Agricultural Experiment Station

of the

University of Kentucky

SIXTY-FIRST ANNUAL REPORT

Report of the Director

for the year 1948

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1948

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LETTER OF TRANSMITTAL

To His Excellency, Hon. Earle C. Clements, Governor of Kentucky:

Sir: In accordance with an act of Congress, approved March 2, 1887, entitled, "An act to establish Agricultural Experiment Stations, in connection with the Agricultural Colleges established in the several states under the provisions of an act approved July 2, 1862, and under the acts supplementary thereto," and of the act of the Legislature of the State of Kentucky, approved February 20, 1888, entitled, "An act to accept the provisions of an act passed by the Congress of the United States, approved March 2, 1887, for the establishment and maintenance of Agricultural Experiment Stations in connection with Agricultural Colleges established by the several states and territories under the act of Congress approved July 2, 1862," I herewith submit the sixty-first annual report of the Kentucky Agricultural Experiment Station.

Very respectfully,

THOMAS P. COOPER, Director.

(See "Index to Subject Headings," pages 77-80)

Effective farm work principles and techniques.—In the project on simplifying farm work, certain principles which govern the way a farm worker can do a given job in the easiest, quickest way have been evolved. Some of the more important of these in hand work such as weeding plant beds, picking fruit, and so on, are as follows: Both hands should contribute equally and simultaneously, and should be kept close together. The eyes should be used to direct the body motions. Work rate should be kept at an even tempo. Materials and supplies should be arranged beforehand within easy reach. Each hand should carry a full load each time so as to reduce number of hand trips required. Proper work heights and convenient arrangements assure a comfortable working position. The work should be planned, and the plan worked.

Other important principles evolved have to do with the time and travel used by the worker on the job: Reduce travel by having buildings and work areas close together. Use "circular travel" to avoid back-tracking. Take advantage of gravity in such equipment as feed chutes and self-feeders. Use wheel conveyers to save time and effort; and make alleys, paths, and doorways sufficiently wide, smooth, and level for such equipment. Plan to complete one operation where another begins. Place tools and supplies for greatest convenience in using them; combine jobs and rearrange for greater accomplishment and economy. Haul maximum practical loads to reduce trips. Avoid wasting energy; work at reasonable speed; plan the work to avoid delays; keep labor and equipment busy. Output per worker is usually greater in small than in large crews.

Off-farm income by operators of small farms.—Information on labor utilization and income was obtained for 103 small farms in seven counties of south-central Kentucky. Fifty-seven of the operators, or 55 percent, reported off-farm work. Types of off-farm employment included work as share croppers, timber and sawmill workers, carpenters, mail carriers, school teachers, farm wage workers, and other day laborers of various kinds. The fifty-seven farmers worked an average of 108 days away from the farm; the days of such work ranged from 10 to 312 days for the year. In most cases this off-farm employment occurred when there was very little productive work on the farm.

Income from off-farm work in 1947 averaged $686, or $6.35 per day for the fifty-seven farmers, and constituted 58 percent of the operators' total earnings. Operators who reported off-farm work averaged $1176 total income; those that did no work off the farm averaged $755. On small farms, where resources do not adequately employ the labor of the operator and his family, some off-farm employment is desirable to supplement farm income.

Cooperative fire insurance.—The amount of farm property in Kentucky subject to loss by fire, wind, and lightning is valued at several hundred million dollars. To get insurance from stock companies is generally difficult and often impossible, since such companies generally prefer an urban business. To meet this situation farmers have organized cooperative fire insurance companies. Out of 36 cooperative companies organized since 1870, 18 that do an essentially rural business are now active. Four others write insurance chiefly on urban property. In 1948 total volume of cooperative fire and storm insurance on farm property exceeded 100 million dollars.

Cooperative insurance has prospered chiefly for two reasons. First, the cooperative companies are owned by farmers and managed by persons familiar with agriculture and able to appraise the insurance hazards of farm property. Second, cooperative insurance is economical. Assessments varied from 25 cents to 83 cents among the different companies and the average for 18 companies was 52 cents per $100 insurance in force for the period 1931-1946.

Changing economic conditions create new problems for cooperative insurance. The present inflation raises serious questions regarding the evaluation of property for insurance purposes. Rising property values and the legal limitations on insurance permitted on individual risks make re-insurance increasingly important. Growing competition from stock companies makes classification of property for insurance more imperative. The new developments seem to call for more complex organization and new procedures in handling insurance. They present a new challenge to cooperative leadership, and particularly do they raise the question of how to make the new adjustments and at the same time preserve the simplicity of operation and intimate contact with farmers which have been important in enlisting the support of farmers in the past.

Effect of placement of fertilizer on pasture yields.—Experiment fields established near Mayfield, Greenville, and Bowling Green in 1947 for comparing surface and subsurface placement of various phosphatic fertilizers and ground limestone on dry-matter yields of permanent pasture on three major soil types were continued. In 1947, subsurface treatments were placed beneath the sod in rows 4 inches deep and 1 foot apart, and surface treatments were applied as top dressings. No further applications were made in 1948. The herbage was harvested by clipping protected

areas (1/500 acre) when it had attained a height of 4 or 5 inches. Yields of dry matter per acre from four clippings each in 1948 averaged for subsurface application 1,633 pounds and for top dressings 1,669 pounds at Mayfield, and 2,725 and 2,879 pounds respectively at Greenville. Yields from treated plots on the Bowling Green field in 1948 were again no larger than from untreated plots, and the field was therefore relinquished as unsatisfactory for these experiments.

Two fertilizer placement experiments were established on permanent pasture near Hodgenville during the fall of 1947. Because of an uneven stand of sweet clover on the pasture, only the last two clippings from the plots were weighed. There was no advantage in subsurface application of either all or part of the fertilizers.

Continuous and alternate grazing compared.—Plots of bluegrass pasture (containing some white Dutch clover) were grazed from April 16 to October 1 (168 days), but about 70 percent of the forage was produced before July 1. Up to this date the yield was among the heaviest recorded during the 13 years of this experiment. When the production of the pastures in terms of requirements for maintenance and growth of dairy heifers was converted to total digestible nutrients (TDN), the total yield was 2,188 pounds TDN per acre for the continuously grazed plot and it was 2,005 pounds TDN per acre for the alternately grazed plot. Weight gained by the heifers was 282 pounds per acre for the continuous and 224 pounds for the alternately grazed plots. These differences were not significant. Lack of rainfall after June 15 caused the yield of TDN per acre and the weight gained per acre by the heifers to fall below the 13-year average of 2,309 and 316 pounds respectively.

Mineral content of forage plants at different stages of maturity.—The mineral composition of alfalfa, sweet clover, Kentucky bluegrass, orchard grass, and Ky 31 fescue plants grown on similar soil types was determined at weekly intervals from April through August. Composition varied with species and stage of growth, and in relation to the effect of drought and summer heat on the growth habits of the plant. Sweet clover at all stages of growth was higher in phosphorus, potassium, and magnesium and lower in calcium than alfalfa. Orchard grass was higher in phosphorus and potassium than any of the other grasses or legumes but it was lower in calcium and magnesium than Ky 31 fescue or Kentucky bluegrass. In general, bluegrass was lowest in all mineral nutrients determined.

Phosphorus content was influenced markedly by stage of maturity, but potassium and calcium content seemed to be affected more by moisture and weather conditions, as evidenced by rather wide fluctuations during the growing season.

Effect of soil treatment and location on the mineral content of red clover and alfalfa.—Red clover produced at Greenville on soil limed to

pH 5.8 was nearly as high in calcium, magnesium, and potassium as that produced on soil limed to pH 6.8. Phosphorus content of the clover was not appreciably influenced by the rates of liming used in this experiment, and was not consistently increased by increasing increments of phosphate fertilizers, although an average of all treatments showed an increase. Potassium content of the clover was not increased much by potash application of 40 or 80 pounds of K_2O per acre; but at applications of 160 and of 320 pounds of K_2O per acre, there was an appreciable increase in potassium content.

Alfalfa grown on farms in nine counties was found to vary from 0.18 to 0.53 percent in phosphorus, from 0.7 to 2.24 percent in potassium, and from 1.05 to 3.0 percent in calcium. All fields were limed and phosphated as needed. The use of potash fertilizer over and above any applied by the farmer had only a slight effect on yield in most cases and caused little increase in the potash content of the hay except at very low levels. Boron used in fertilizers in these tests caused an increased growth of better alfalfa but had little effect on the phosphorus, calcium, and lime content of the herbage.

White clover varieties.—White and Ladino clover strains sown in September 1947 produced from one cutting made August 5, 1948 the following pounds of dry matter per acre: Central Kentucky white, 266; West Kentucky white, 231; Louisiana white, 181; Kentucky certified Ladino, 667; Oregon certified Ladino, 628; and commercial Ladino, 570.

Alfalfa varieties.—Two lots of Argentine alfalfa sown in August 1945 produced 3,676 and 3,725 pounds of dry matter per acre from three cuttings; Buffalo produced 5,064 pounds; Ranger, 4,962; Hardigan, 5,365; one lot of Kansas Common, 4,021; Kentucky 41, 4,845; two lots of Oklahoma Common, 4,051 and 4,347; and Atlantic, 4,705 pounds.

Red clover varieties.—Six lots of certified Cumberland red clover from different sources produced 2,186 to 3,077 pounds of dry matter per acre from two cuttings; certified Kentucky 215 produced 2,715 pounds; Wisconsin mildew-resistant, 418 pounds; and four lots of Kenland produced 2,913 to 3,407 pounds. The Kenland lots represented different seed generations, stands of different ages, and seed from different regions. Seed from stands 2 years old produced hay yields about 6 percent larger than seed from stands 1 year old.

The six lots of Cumberland red clover, which were sown April 1947, had an average of 2.6 plants per square foot on October 26, 1948; Kentucky 215, 1.7; Wisconsin mildew-resistant, 0.6; and Kenland 7.0 plants. (These and other red clover studies are in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.)

Rate of seeding and row spacing for red-clover seed production.—Attention was given primarily to rates and spacings of seeding for seed production. Because of rainy weather, seedings were made April 26, 1948, at least a month later than desirable. Broadcast seedings in rows 6, 12, 18, 24, 30, and 36 inches apart. About 1 pound of seed per acre was seeded in the wider rows, and up to about 2 pounds per acre in the narrow rows. Yields of seed per acre were 7, 11, 31, 35, 31, 26, and 31 pounds, respectively. Inasmuch as the seedings were made late and the weather was quite dry during the development of the seed crop, these yields suggest that 18 to 36-inch row seeding may be best for multiplying quickly the seed of a new variety of red clover in Kentucky.

Kenland sown in 30-inch rows in the fall of 1947, with a seeder attachment on a cultipacker, produced 84 pounds of seed per acre from the second crop in 1948.

Alfalfa seed production.—The Atlantic variety of alfalfa was sown in August 1947 at the rate of 5 pounds of seed per acre for seed production studies. Limestone and muriate of potash had been applied to the land in 1944 at rates per acre of 1¾ tons and 200 pounds, respectively. Second applications were made prior to seeding in 1947 at rates of 2 tons and 200 pounds per acre, respectively. The first crop in 1947 was cut for hay in the early bloom stage. The second crop, which developed in dry weather, produced 134 pounds of seed per acre, threshed from the swath with a combine. Yields obtained by quantitative threshing of randomized samples showed that all the seed was saved in combining. This was accomplished, however, only by giving constant attention to the combine to keep it operating properly.

Effect of DDT on seed production in red clover and alfalfa.—Collections of insects were made in 1948 from four plots of red clover and one plot of alfalfa to determine species most likely to affect seed production. The plots were treated in the early bloom stage with DDT in the form of a 5-percent dust to control harmful species, at approximately 35 pounds per acre. The tarnished plant bug, Lygus oblineatus, was present in all collections and was the most destructive of the insects found. The DDT dust killed 67.2 percent of this bug. The potato leafhopper, Empoasca fabae, was also rather numerous, and DDT killed 87.5 percent of this species. Lady beetles did not appear to be affected by the DDT dust. There were practically no bee pollinators on the red clover plots, but on the alfalfa, honey bees, bumble bees, and solitary bees were present in considerable numbers.

Pounds of seed obtained per acre were: dusted Atlantic alfalfa, 158.2; undusted Atlantic alfalfa (check), 88.5; dusted Kenland red clover, 101; undusted Kenland red clover (check), 77.

Kentucky bluegrass plant bugs, Miris dolobratus and Amblytylus nasutus.—The plant bugs *Miris dolobratus* and *Amblytylus nasutus* were found in 1948 in about the same numbers as in 1947. *M. dolobratus* was found in injurious numbers on one farm where collections were made at regular intervals. The numbers varied in 12 collections from 0.56 to 17.6 per sweep of an insect net, with an average of 6.7 per sweep. Adults were found from May 8 to June 3 in the fields.

Amblytylus nasutus in 12 collections varied from 5.6 to 90.8 per sweep. This bug did considerable damage this season. Adults were found first on May 11 and all nymphs had transformed to the adult stage by June 3.

Insecticides were applied for control on April 30 and May 3, before adults of either bug were found. A dust containing 5 percent DDT and applied at the rate of 35 pounds per acre and an emulsion containing DDT when applied at the rate of 1½ pounds of DDT per acre, in 50 gallons of water, gave perfect control of both insects. A dust containing 5 percent of Chlordan was not quite as effective as DDT. This dust killed 88 percent of *Miris dolobratus* and 96 percent of *Amblytylus nasutus*.

Adults of both insects began migrating into treated plots approximately 2 weeks after insecticides had been applied. Large fields could be kept practically free of both insects with one application of DDT, if applied when the insects were in the nymph stage.

Effect of DDT on seed production of Kentucky bluegrass.—In order to test the effectiveness of DDT as an insecticide in destroying the bluegrass plant bugs *Miris dolobratus* and *Amblytylus nasutus* and also to determine the extent to which these insects affect the seed crop, a test was conducted on a 100-acre pasture in Fayette county. One area comprising 3 acres in the center of the field was dusted on May 14, 1947, with 5 percent DDT dust at the rate of 30 pounds to the acre. A like area on either side was not dusted. It was found that DDT gave nearly complete control of both insects during the seed production period. Seed production on the dusted and the undusted plots were as follows:

	Rough-Cured Seed per Acre *bu*	*Cleaned Seed per Acre* *lb*	*Recovery of Cleaned Seed* *%*
Untreated	28.2	154	37.6
Dusted with DDT	36.0	289	56.8

These plots had not been fertilized with nitrogen. Plots that were fertilized with 60 pounds of nitrogen to the acre early in March and subsequently treated with DDT in May produced an average yield of 602 pounds of clean seed per acre. Destruction of the insect population increased the recovery percentage of clean seed to a high level without the use of any nitrogen fertilizer, indicating that insects have been largely responsible for the decline in quality of the bluegrass seed crop in Kentucky in recent years.

Effect of nitrogen fertilizer on seed production of Kentucky bluegrass.— Plots of good bluegrass sod in the central Bluegrass region were top-dressed in early March 1947 with 20, 40, and 60 pounds of nitrogen per acre in the form of ammonium nitrate. Each plot was dusted with 5 percent DDT at the rate of 30 pounds to the acre on May 14, 1947, to destroy destructive insects. Effects of the nitrogen treatments on seed production in 1947 were as follows:

Nitrogen per Acre, pounds	*Rough-Cured Seed per Acre*	*Clean Seed per Acre*	*Recovery of Clean Seed*	*Number of Panicles per Acre*
	bu	*lb*	*%*	*(000)*
0	36.0	289	56.8	3,498
20	50.0	417	59.4	4,354
40	59.3	506	60.9	4,440
60	69.0	602	61.8	5,024

Effect of sod management on seed production of Kentucky bluegrass.— In six tests in the central Bluegrass region, in 1947, of the effect of clipping and sod fertilization on seed production in Kentucky bluegrass, a single autumn clipping of bluegrass with a sickle-bar mower was followed by a signifcantly lower yield and percentage recovery of clean seed, although the number of panicles per acre was increased. Top-dressing of the sod with ammonium nitrate (33 lb N per acre) was only partially effective in overcoming the unfavorable effects of autumn clipping.

Timothy varieties.—Five timothy varieties were compared in a replicated test on 1/318-acre plots sown in the fall of 1947. Yields of dry matter per acre obtained from a cutting for hay on May 17, 1948 were as follows: Shelby, 2,863 pounds; Milton, 2,693 pounds; Marietta, 2,539 pounds; Drummond, 1,878 pounds; and Paton, 722 pounds. All the varieties were moderately affected by leaf diseases. Paton, a Canadian pasture selection, was the only fine-leaf strain in the test.

Orchard grass varieties and strains.—Yields of 10 strains of orchard grass harvested as pasturage ranged from 4,327 to 5,039 pounds of dry matter per acre. The lowest yield was obtained from the strain developed by the Experiment Station. In 1947 this strain produced the highest yield.

Seventeen varieties and strains of orchard grass sown in 1947 were harvested for herbage yields for the first time in 1948. Yields of dry matter ranged from 2,786 to 5,788 pounds per acre. The seven highest yields were produced by old Kentucky strains. All varieties of English and Canadian origin produced very few stems and panicles and relatively low herbage yields. A strain developed by the Experiment Station was definitely superior in disease resistance and in retention of green color during drouth and after frost.

Fescue varieties and strains.—Herbage yields of tall fescue strains obtained from three clippings ranged from 2,945 to 5,193 pounds of dry matter per acre. Kentucky 43, which produced the largest yield in 1947,

produced the lowest yield in 1948. Alta fescue, which produced one of the lowest yields in 1947, produced the highest yield in 1948. Other strains showed similar but less pronounced reversals in relative yields. These marked reversals, and those also of orchard grass, suggest the influence of available nitrogen balance in the soil.

A new tall fescue strains test, sown in the fall of 1947, was harvested twice in 1948. Yields ranged from 6,773 to 8,827 pounds of dry matter per acre. Two old Kentucky strains produced the highest yields. One of the strains developed by the Experiment Station produced a high yield and was highly disease resistant. Kentucky 31 was more resistant than Alta to leaf diseases in mid-May.

Time of applying nitrogen fertilizer for seed production of orchard grass and Ky 31 fescue.—Plots in 3-year-old orchard grass and Ky 31 fescue sods were fertilized with ammonium nitrate at the rate of 100 pounds per acre—some in October, some in January, some in February, and others in April. They were given no other special treatment. The nitrogen applications had no measurable effects on seed yields, and there were no significant differences in test weights of the seed. Yields were only one-fourth to one-third as large as in 1947, when the sods were 2 years old.

Effect of sod management on seed production of orchard grass and Ky 31 fescue.—Four ways of management of 3-year-old sods of orchard grass and Ky 31 fescue were studied: (1) no clipping or other treatment except a single removal of herbage immediately after seed harvest; (2) continuous clipping from seed harvest until late fall; (3) early spring or late winter burning; and (4) early spring or late winter burning plus top-dressing of ammonium nitrate at the rate of 100 pounds per acre in the spring. Seed yields obtained were only one-fourth to one-third as large as in 1947, when the sods were 2 years old. None of the treatments were favorable to maintaining high yields of seed as the sods become older.

Effect of method and rate of seeding on seed production of orchard grass and Ky 31 fescue.—Yields and test weights of clean seed of orchard grass and Ky 31 fescue produced in 1948 from broadcast seedings made in 1946 at 3, 7, and 15 pounds per acre and row seedings spaced 27 inches apart are as follows:

Seeding	*Acre-Yield*		*Test Weight*	
	Orchard Grass	*Ky 31 Fescue*	*Orchard Grass*	*Ky 31 Fescue*
Broadcast	*lb*	*lb*	*lb/bu*	*lb/bu*
3 pounds per acre	155	277	12.4	15.9
7 pounds per acre	142	167	12.4	16.3
15 pounds per acre	122	162	12.3	15.6
Rows 27 inches apart	323	779	12.3	17.3

Yields obtained in 1948 from broadcast seedings were from 28 to 36 percent of those obtained in 1947. Yields from the row seedings, on the other hand, were 43 percent and 91 percent, respectively, of those obtained from orchard grass and Ky 31 fescue in 1947. For seed production, row planting thus became increasingly superior to broadcast planting.

Effect of 2,4-D sprays on Ky 31 fescue seed yields.—To control broad-leaved weeds in row-drilled Ky 31 fescue seed crops 2,4-D was used at rates of 0.5, 1, and 2 pounds per acre of 2,4-D acid in isopropyl ester and triethanol-amine formulations, and at 1-pound rate in the sodium salt (monohydrate). Low-volume sprays (7½ gallons per acre) were applied April 19 when fescue plants were 6 to 8 inches high and before boot stage of development. The average yields of recleaned seed from triplicated plots where 2,4-D was applied were slightly larger than where the plots were not sprayed, except that where the 1-pound rate of the ester was applied the yield was slightly smaller and where the 1-pound rate of sodium salt was applied the yield was significantly smaller. The yield of the unsprayed plots was 541 pounds. Although the 1-pound and 2-pound rates of 2,4-D in the amine or ester forms resulted in appreciably better weed control than the 0.5-pound rate, the 2-pound rate which is suggested for controlling wild garlic caused no reduction in seed yields. The reduction in amount of large weed growth due to the treatments greatly facilitated combine threshing of the seed and simplified the recleaning.

Control of brambles and brush with 2,4-D and 2,4,5-T.— Preliminary trials made in September indicate that effective kill of brambles, brush, and woody type plants late in the season may be possible by spraying with mixtures of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid. Materials containing one-fourth and one-half 2,4,5-T and the remainder isopropyl ester of 2,4-D and applied at the rate of 4 pounds of acid per acre appeared to give complete kill of blackberry canes, while smaller amounts of 2,4,5-T showed only partial killing. Very small amounts of 2,4,5-T and 2,4-D alone killed the leaves of blackberry but apparently had no effect on the woody portions of the plants. Wild cherry, hawthorn, and other hardy shrubs showed leaf killing with all formulations, but the permanent effect on the wood has not been determined. Plants more resistant to 2,4-D, such as poison ivy and lambs quarters, were easily killed with 2,4,5-T.

Buckbush growing along fence rows in pastures at Lexington was completely killed by mid-April spraying with the ester form of 2,4-D. Two pounds of the acid equivalent in 10 gallons of water was applied with a small-orifice nozzle (rated at 5 gallons per acre) so that the leaves and stems were moistened slightly, without runoff.

Taxonomy of white grubs.—A study was made of larvae of the scarab subfamily Melolonthinae, which includes many species of economic importance. Characters were found for distinguishing genera, including two genera previously unknown in the larval stage. Genera studied were *Phyllophaga*, *Polyphylla*, *Listrochelus*, *Amphimallon*, *Serica*, *Diplotaxis*, *Phobetus*, *Dichelonyx*, *Coenonycha*, *Macrodactylus*, *Plectris*, and *Hoplia*.

White grub control with benzene hexachloride.—Three types of benzene hexachloride, consisting of a dilute emulsion and two dusts, were compared early in May, in small replicated field plots, for the control of second-instar May beetle *(Phyllonphaga)* grubs which are frequently injurious to bluegrass sod. Each material was so diluted that in each case 5 pounds of the gamma isomer of benzene hexachloride was applied per acre. Counts were made a month later and compared with untreated check plots.

Dilute benzene hexachloride emulsion, applied at the rate of 1 quart per square foot, gave an average mortality of 83 percent. A wettable benzene hexachloride powder, applied to the surface of the sod and then watered with 1 quart of water to the square foot, gave a mortality of 32 percent. A powder containing mainly the alpha and beta isomers of benzene hexachloride, applied to the surface in the same manner as the wettable powder, gave a mortality of only 14 percent.

Control of green June beetle larvae.—In the spring of 1943, lead arsenate in amounts of ½, 1, and 2 pounds per 100 square feet was applied to Kentucky bluegrass sod to determine its effectiveness in controlling green June beetle larvae for one or more years. There were six replications of each treatment and 6 checks or untreated plots. The control from the treatment the sixth year (1948) was too low to be very effective. The ½ pound treatment killed 42.6 percent of the grubs, the 1 pound treatment killed 49 percent, and the 2 pound treatment 58.8 percent.

Benzene hexachloride at the rates of 2 and 3 pounds of the gamma isomer per acre and chlordan at rates of 3½ and 5 pounds per acre were used in the spring of 1948 for controlling the grubs. These chemicals were worked into the soil to a depth of 3 inches. Each treatment was replicated 5 times and there were 5 untreated plots. In plots where 2 pounds of the gamma isomer was used, an average of 97 percent of the grubs were killed, and in plots where 3 pounds of the gamma isomer was used, an average of 96 percent were killed. Chlordan at 3½ pounds per acre, killed 26.5 percent of the grubs, and at 5 pounds per acre, killed 38.9 percent of the grubs.

Control of green June beetles.—The green June beetle, *Cotinis nitida* (L.) was unusually abundant in 1948. The grubs were destructive to tobacco beds and golf courses and the adults did considerable damage to ripening peaches and other fruits. A number of dust and spray materials

were tested in the laboratory as control measures for the adults. Sprays tested were pyrethrum, sabadilla, chlordan, benzene hexachloride, and parathion. Of these, parathion was outstanding, killing all the beetles when used at the rate of 1 or 2 pounds of a 25 percent wettable material per 100 gallons. Results with all the other spray materials were poor in the laboratory, but in field tests good control was also secured with a benzene hexachloride spray containing 2 pounds of the 25 percent gamma isomer of benzene hexachloride per 100 gallons.

Dusts tested were 10 percent DDT, 20 percent toxaphene, 5 percent chlordan, 1½ percent gamma isomer benzene hexachloride and 2 percent parathion. Benzene hexachloride gave a 50 percent kill while the parathion killed 93 percent of the beetles. Other dusts tested were ineffective.

Use of flame photometer in determining potassium and calcium.—The accuracy and convenience of the flame photometer for determining potassium and calcium were investigated. A set of twenty-four plant samples was ashed in duplicate and the potassium content determined twice in each ashing by the ordinary sodium cobaltinitrite method. Values obtained were averaged and compared with those from a single ashing and determination with the flame photometer. Much less time was required in analysis with the flame photometer. Results were 2 to 4 percent higher by the photometer method, but were reproducible within 1 percent, whereas with the chemical method variation between duplicates was as much as 5 percent. Similar results were obtained in determining calcium, but much greater care was required in operating the instrument. The method was very satisfactory for routine determinations of calcium.

Improved method for determining sugar in plant materials.—Ordinary methods for determining sugar in plant materials are long and cumbersome. They require a long Soxhlet extraction with alcohol, precipitation of proteins with lead acetate, and deleading with oxalate. It was found that for ordinary reducing and total sugar determinations in tobacco and many other tissues, an extraction with water for 5 minutes in a Waring blendor gave equally satisfactory results. Clarification was easily effected by adding animal charcoal to the sample in the blendor. After filtering, the sugar was determined by a modified Folin-Wu colorimetric procedure, using a variation of the developing reagent described by Andes and Northrup. Enzyme activity had little effect on results if the solutions stood no more than an hour before determinations were made.

Varieties of winter wheat.—Yields and test weights of winter wheat grown in test plots on the Pennyrile field in Todd county were considerably affected by black stem rust. Two early varieties (Redhart and Purcam) escaped serious damage, and yielded 38.0 and 45.6 bushels per acre respectively. Nine other varieties were severely damaged, the yields ranging from 18.1 bushels (Forward) to 27.4 (Goens). Test weights of the

damaged varieties ranged from 43 to 53.5 pounds per bushel in comparison with 56 and 57 pounds for Redhart and Purcam. Yields were also considerably reduced by stem rust in a test of five varieties in Daviess county, although the damage was not as severe at that location.

In the yield tests at Lexington stem rust was not present in damaging amounts, but leaf rust was heavy on susceptible varieties. Several new strains combine high yield, satisfactory straw strength and test weight, and resistance to stem and leaf rust. These are being increased for quality and yield tests.

On the basis of tests during the last three years, two more varieties were placed on the recommended list this year. Vigo is recommended for growing anywhere in the state. It has given a slightly higher average yield than other recommended varieties, has a higher test weight than Thorne, and stands well for harvesting. It is moderately resistant to leaf rust and loose smut but is susceptible to stem rust. It is an excellent milling variety. Redhart is recommended only for the Pennyrile area when an early harvest is desired, and because of the possibility of winterkilling, should not be grown in the northern part of the state. This variety matures about a week earlier than other commonly grown varieties, and this has enabled it to escape serious damage from leaf and stem rust. The quality of Redhart is acceptable to the milling and baking trade.

Varieties of winter barley.—Of 28 varieties grown in tests at Lexington and Todd county, Ky 1 barley continues to be one of the highest yielding of the named varieties. Ky 1 is surpassed only by Davidson and Jackson 1 in southern Kentucky, and by Nassau at Lexington. No winterkilling occurred at either location this year. From other tests, all three of the highest yielding varieties are known to be less winter-hardy than Ky 1 in severe winters. Jackson 1, a smooth bearded variety, appears promising in the Pennyrile, and may be hardy enough for that area in most years.

Several experimental strains outyielded all other varieties at both locations. Some of these strains have some resistance to mildew and loose smut and are being tested in Northern states for hardiness.

Varieties of fall-sown oats.—Eight oat varieties fall-seeded in field plots in the Pennyrile field in Todd county averaged 101.4 bushels per acre, ranging from 76.1 (Fulwin) to 119.9 bushels per acre (Fulgrain). There was no winterkilling in this test or in the nursery test at this location. In nursery tests at Lexington, most varieties survived the winter with 90 percent stand or better, and the yields of 41 strains averaged 64.8 bushels per acre. Thirty-seven strains in the Pennyrile nursery averaged 84.0 bushels per acre. Several new strains of Lee-Victoria × Fulwin which appear promising from the standpoint of combining winterhardiness, crown rust resistance, and strong straw, were seeded in field plots in Todd county for yields in 1949.

Varieties of spring oats.—Yield tests of spring oats were conducted only at Lexington. Thirty-six varieties and unnamed strains averaged 50.4 bushels per acre. Because of dry weather during most of the growing season, *Helminthosporium* disease was not as severe as in the past two years. Susceptible varieties seeded from untreated seed were badly killed in the seedling stage.

Early maturing varieties such as Columbia, Mindo, and Andrew, continued to yield slightly higher than those of average maturity, including Clinton and Benton. Mindo and Andrew have stronger straw than Columbia, but not as strong as Clinton. All of these varieties are resistant to *Helminthosporium*, and all except Columbia have high resistance to the rusts.

Effect of 2,4-D treatments on winter barley.—Plots of winter barley sprayed with ½- and 1-pound rates of 2,4-D acid in amine and ester forms were practically free of annual weeds where the treatments were applied April 10 (barley 6 to 8 inches tall), but later treatment on April 21, when the barley was approaching the boot stage, had no effect on weed control. Spring seeding of clover was killed with the early spraying, but was not affected by the later spraying. Barley on plots sprayed with 1 pound of 2,4-D acid per acre in the ester form was shorter and later than that on plots sprayed with the ½-pound rate, at both the early and late applications. Barley sprayed with the 1-pound rate of ester on April 21 was 4 to 6 inches shorter and 3 to 5 days later heading than that on the untreated plots. Some sterile florets also occurred in some varieties. With the exception of the Reno variety, fields were lower in all plots treated with the ester formulation than on untreated plots. There was no difference in growth or yield between untreated plots and plots sprayed with the amine formulation, at either the early spraying or the late spraying.

In an additional test replicated plots of Ky 1 barley were sprayed on April 8 when the barley was about 8 inches tall with 1½- and 1-pound rates of 2,4-D acid in sodium salt, amine, and butyl ester forms. Plots sprayed with the 1-pound rate of butyl ester were 2 inches shorter than other plots at harvest, with the heads upright. Yields on these plots were somewhat higher than untreated plots, while those treated with amine formulation were slightly lower, although none was statistically significant. Weights per bushel were unaffected by the spray applications. Number of garlic plants producing bulblets was reduced with all treatments but none of the treatments completely prevented seed-head formation. Applications of 2,4-D can be used effectively to control weeds in barley with little or no injury to the barley when applied early in the spring before the seed heads begin to form.

Effects of 2,4-D treatments on winter wheat.—Thirteen varieties of winter wheat sprayed with ½- and 1-pound rates of 2,4-D acid in the

amine and butyl ester forms were only slightly affected in the early stages by the 1 pound rate of ester applied April 10 (wheat 8 inches tall). However, at harvest the wheat on these plots was nearly 6 inches shorter than on untreated plots and the leaves were standing erect. Delaying the spraying until April 21 when the wheat was 18 inches tall reduced the height of the plants slightly when sprayed with the ½-pound rate of ester. Wheat sprayed with the 1-pound rate of ester at this stake was 6 to 8 inches shorter at harvest time than that on untreated plots and was later heading. 2,4-D in the amine form appeared to have no effect on the growth of the wheat. There appeared to be no consistent effect on yields with any of the rates of application or 2,4-D formulations, although varieties varied considerably.

Effects of 2,4-D treatments on spring oats.—Varying amounts of 2,4-D in sodium salt, amine, and ester forms were effective in controlling plantain, dock, dandelion, buckhorn, and white top in Columbia spring oats at all stages of growth. The ¼- and ½-pound rates were slower in action and some dock plants which were more mature at the time of spraying produced seed heads. All applications in the ester form and 1- and 2-pound rates of amine and sodium salt forms reduced the yield of oats significantly below that of the untreated plots, the reduction being greatest when 2,4-D was applied late in the season. Test weights did not differ significantly.

Relation between yield and net returns in corn production.—Corn-production costs and returns on 109 farms in 1946, and profitable corn-production practices on 569 farms producing relatively high corn yields in 1946 and on 817 similar farms in 1947, were studied. As yields increased the average costs per acre for seed, fertilizer, manure, labor, and power tended to increase, but growing and harvesting cost per bushel of corn produced decreased from 64 cents for the farms that produced less than 40 bushels of corn per acre to 36 cents per bushel for the farms that produced over 100 bushels per acre. With corn valued at $1.25 per bushel, the net returns for use of land, seeding a cover crop, and management of corn production ranged from 64 cents per bushel for the farms that produced less than 40 bushels per acre to 89 cents per bushel for the group that produced over 100 bushels per acre.

Costs per acre to share tenants for producing corn in five south central Kentucky counties averaged $20.87 and ranged from $18.46 for those with low yields to $25.14 per acre for the high-yield group. In the rental agreements used most frequently the tenant furnished half the seed and fertilizer and all the labor, power, and equipment, and received half the corn produced. The average value of the tenant's share of the corn, at $1.25 per bushel, ranged from $19.44 per acre for the group with lowest yields to $69.00 for the group with highest yields. Therefore, the net

returns to the tenant varied from $0.98 per acre in the low-yield group to $43.86 per acre in the group with highest yields.

Many factors within the control of the individual corn producer influence the amount of profit realized from corn production. Use of hybrid seed corn rather than open-pollinated varieties increased yield by 33 percent on the average—a very profitable practice. The rate of planting greatly affected the yields produced, especially on land of high fertility. In this study 100 plants were required to produce a bushel of corn, on the average.

Yields of certified and experimental corn hybrids.—Fourteen white hybrids and 10 yellow hybrids were grown in comparison with Boone County White and Reid Yellow Dent, open-pollinated varieties, in yield tests in Fayette, Todd, Caldwell, Daviess, Jefferson, Madison, Breathitt, and Lee counties. In addition several other hybrids were tested in individual locations. Wet weather following planting in Breathitt and Lee counties caused very poor stands and the yield results were not reliable. In Madison county the test had to be replanted, making the crop extremely late, and the yields are therefore not reported. The season was favorable for corn in the other locations. Average yield of the 26 varieties for all locations was 87.2 bushels per acre. In the counties the yields were, Fayette county, 65.9 bushels per acre; Todd county, 72.1; Caldwell county, 86.1; Daviess county, 122.6; and Jefferson county, 84.6.

The white hybrids averaged 90.7 bushels per acre, which was 13.9 bushels (18.1 percent) more than Boone County White; and yellow hybrids averaged 84.1 bushels per acre, which was 3.6 bushels (4.5 percent) more than Reid Yellow Dent. During favorable seasons, such as 1948, differences between hybrids and open-pollinated varieties are not so great as during adverse seasons for corn.

Several experimental white hybrids were higher yielding than the commercial hybrids being certified. Notable among these was Ky416, which outyielded Ky203 by an average of 15.1 bushels per acre. Ky416 stands up well but is late maturing; it will probably be satisfactory in areas where corn can be left in the field late in the season. Dixie 17, tested for the first time in the state-wide tests, was high yielding but somewhat late. Ky423, Ky418, Ky410, Ky408, Ky405B, and Indiana 750 all continued to perform satisfactorily. Ky7114 showed considerable promise as a medium-maturing hybrid. All of the yellow hybrids were generally similar in yield. Ky 173 was highest yielding but was tested in only two locations. Ky7001, tested for the first time in the state-wide tests, shows considerable promise in yield and standability.

New corn hybrids certified.—Two white hybrids, Ky405B and Indiana 750, and the yellow hybrid Ky158 were released to seed producers for certification in 1948. Ky405B and Ky158 have been grown in

demonstration plantings on individual farms the past two years and have been well liked. Reports on Ky405B show it to yield as well as Ky203, that it stands up better, and that it produces very sound corn. Ky158 has been equal to or better in yield than Ky103 and has produced uniform, sound ears. Individual farmers have reported it to be more drought resistant and to hold its green color later in the season. Moisture of the grain at harvest has been slightly higher than Ky103 by virtue of holding its green color longer. About 700 bushels of Ky405B and 4,500 bushels of Ky158 are available for commercial planting in 1949.

Indiana 750 has performed very favorably for Kentucky farmers. It has yielded well, is fairly early, and stands up well for harvesting mechanically. In some areas in the state it has been reported to be variable in quality. There is a plentiful supply of seed in both Kentucky and Indiana for 1949 plantings.

Yields of commercial corn hybrids.—Tests of commercial hybrids sold and grown in the Pennyroyal district were continued in Todd county in cooperation with the Pennyrile Grain Improvement Association. Twenty-seven hybrids were included in the test in 1948, the average yield of all entries being 79.1 bushels per acre. There was no significant difference in yield in the top 10 hybrids. Some hybrids ranking high in 1947 were relatively low in rank in 1948, although yields in 1948 were higher than in 1947. Some other hybrids were higher in rank in 1948 than in 1947. The white and yellow hybrids averaged 82.1 and 77.4 bushels per acre, respectively, which is similar to 1946 but the reverse of 1947 when the yellow hybrids averaged higher in yield. Higher yields were also obtained with the later maturing hybrids, which is again similar to 1946 and the reverse of that in 1947. Favorable conditions during most of 1948 allowed the later maturing hybrids to make full use of the growing season.

Twenty hybrids tested in 1947 were repeated in 1948 and 13 hybrids have been tested for three years. On the basis of 2-year average yields, Funk G515W was the highest yielding white hybrid while there was no significant difference in yield between the top 11 yellow hybrids. On the basis of 3-year-average yields, Funk G515W, M5, and Ky203 were the best yielding white hybrids and US13, Ky103, Princeton Farms 818, and Pioneer 300 the best yellow hybrids.

Relative yields of commercial corn hybrids at different levels of fertility.—Relative yields of five Kentucky certified hybrids on plots having different levels of soil fertility at the Greenville Experiment Field were practically the same in 1948 as in the previous three years. The results differed from previous years in that Ky72B outyielded Ky203 on four of the six fertility levels and the average of all plots was 1 bushel in favor of Ky72B. Ky102 continued to outyield US13 and Ky103 at all levels

of fertility. The average yield for the four years on all levels of fertility were as follows: Ky102, 58.7 bushels per acre; Ky203, 57.8; Ky72B, 56.4; Ky103, 51.8; and US13, 49.6 bushels per acre. The average yield of all the hybrids in 1948 on the untreated plot was 11.5 bushels and on the plot receiving manure, limestone, and superphosphate, 75.6 bushels per acre. The corresponding averages for the four years have been 9.1 and 76.2 bushels per acre.

Male sterility in corn hybrids.—Studies on male sterility were continued in 1948 with the purpose of determining the methods by which male sterility is inherited in white hybrids and also to determine what inbred lines may carry the sterility factors. The results confirmed those of 1947 that male sterility, resulting in poor seed set, will occur in crosses which have a cytoplasmic contribution from 33-16, and that certain contributions are required from the male parent. Sterility seems to occur only when 33-16 (possibly also Ky27 and Mo2RF) is used as the seed parent in making a single cross or as the seed parent of the seed-parent single cross in making a double cross hybrid, providing the necessary contributions are present in the male parent.

No definite mode of inheritance of the sterility factors was determined. One yellow hybrid was found to carry sterility factors similar to 33-16 and several yellow hybrids were found to carry pollen sterility. However, the sterility in the yellow hybrids may be of a different character than in the white hybrids.

Since some plants in male-sterile hybrids appeared to shed pollen normally, it has been questioned why such poor seed set should result. Studies carried out at Lexington in 1948 showed that such plants shed an average of only 67 percent as much pollen as the plants in normal hybrids. This reduction in amount of pollen along with the plants that shed no pollen appears sufficient to result in reduced seed set.

Corn response to potassium on unmanured land at the Mayfield soil experiment field.—At the Mayfield soil experiment field are plots which, from the time the field was started in 1913, have received limestone and phosphate but no manure. Most of the crop residues also are removed from these plots. In the spring of 1948, one of these plots to go in corn was divided. Sixty pounds of nitrogen per acre was applied to half of the plot, and this amount of nitrogen plus 80 pounds of K_2O was applied to the other half. Corn yield on the half receiving only nitrogen was 51 bushels and on the half receiving potash in addition to nitrogen, 74 bushels; an increase of 23 bushels for the 80 pounds of K_2O.

Increase in corn yields from farm manure.—Change in the plans of the outlying soil experiment fields in the spring of 1948 made it possible to obtain data on the response of corn to application of farm manure this year. At the Campbellsville field on plots treated with limestone and

superphosphate, an application of 8 tons of manure per acre increased corn yield 17 bushels. At the Mayfield field on plots treated with superphosphate, 10 tons of manure increased the yield 19 bushels. At the Greenville field, 10 tons of manure applied on plots treated with rock phosphate increased the yield 22 bushels. At this field, however, application of the same amount of manure on plots receiving no other treatment increased the yield 25 bushels. The same amount of manure at the Berea field on otherwise untreated soil, increased the yield 22 bushels. On another plot, at the Berea field, which in the spring received 4 tons of ground limestone and 10 tons of manure, the increase in yield from manure and limestone was 31 bushels. As an average of all these responses, corn yield increased 2.2 bushels for each ton of manure applied.

Fertilizing corn on Tilsit silt loam.—Response of corn on Tilsit silt loam to application of nitrogen, phosphorus, and potassium was determined in two experiments; one in Warren county and one in Logan county. The areas selected for these tests were in lespedeza pasture. Commercial fertilizers had not previously been used but the areas had received two tons of ground limestone per acre. The plant foods were applied at the acre-rate of 50 pounds of nitrogen and 40 pounds each of P_2O_5 and K_2O. Average acre-yield on the unfertilized plots was 27.0 bushels. Yield was increased practically none when nitrogen and potassium but no phosphorus were applied; 20 bushels when phosphorus and potassium but no nitrogen were applied; 24 bushels when nitrogen and phosphorus but no potassium were applied; and 27 bushels when all three plant foods were applied.

Pre-emergence treatments with 2,4-D to control weeds in corn.—In two tests 2,4-D was applied on corn ground shortly before the corn came up. In one where corn was planted May 15 and dry weather lasted for a month afterward, weeds were only partly controlled and the corn yields were only 60 percent as high as on the clean-cultivated plots; while in the second test, with corn planted June 15 and good rains coming during the week following treatment, practically no weeds came up in the corn and the yield was somewhat greater than on the cultivated plots. There was no apparent injury to corn by the 2,4-D treatments in either test. In both tests 2,4-D in the amine form was used at the rate of 2 pounds of acid per acre. In the first test, 2,4-D treatment supplemented with a late cultivation resulted in a slightly greater yield of corn than from plots cultivated and hoed twice to control weeds. Substitution of late spraying for the late cultivation on pre-emergence treated plots resulted in control of the broad-leaved weeds and in yields of corn 80 percent as large as yields of the twice cultivated plots. The late spray contained 1/5 pound of 2,4-D acid per acre.

In comparison of different 2,4-D formulations, the isopropyl ester was significantly better than the amine or sodium salt in dry weather, giving

fairly good weed control and yield of corn about 90 percent of that of the clean-cultivated plots. Under the favorable moisture conditions of the late corn tests the ester, amine, and sodium salt forms of 2,4-D were about equally effective in preventing weed growth, and yields of corn following their use were approximately equal.

Rates of 1, 1½, 2, 2½, and 4 pounds of 2,4-D acid in the sodium salt form all gave about equally poor control of weeds in the early planted corn and resulted in yields not significantly different. Low-gallonage sprays—6¼ gallons per acre—were just as effective as larger volumes—12½ and 35 gallons—though the mist produced in the lower volume spraying tended to drift worse in windy weather.

Control of weeds in growing corn with 2,4-D.—Tests of 2,4-D sprays for controlling weeds in growing corn were conducted on quadruplicate plots at the Experiment Station farm during 1948. Dry weather, unfavorable to 2,4-D treatment, persisted for a month after corn was planted and in general throughout the growing season. The rank growth of weeds on uncultivated, unsprayed plots resulted in a near failure of the corn, the average yield being 7.2 bushels per acre. Corn on the clean-cultivated plots (two cultivations and hoeings) produced 57.2 bushels. 2,4-D sprayed on other plots at the rate of 1/5 pound of 2,4-D acid when corn was 10 to 18 inches high killed the broad-leaved weeds but permitted crabgrass to come more heavily, resulting in yields of corn only 42 percent as great as those of the clean-cultivated plots. The ester, amine, and sodium salt formulations of 2,4-D were about equally effective. A late cultivation to destroy the crabgrass in certain plots previously treated with 2,4-D, together with late spraying for weeds in the corn rows, resulted in yields nearly double those of the plots which received only the early spray treatment, yet were only 80 percent of the yield of clean-cultivated corn. 2,4-D sprayed when the corn was 3 to 4 inches high gave early weed control and resulted in 50 percent larger yields of corn than on plots where the spraying was delayed until the corn was 10 to 18 inches high. Further delay in spraying until the corn was 24 to 36 inches high and 48 to 60 inches high resulted in progressively lower yields, even though the rate of 2,4-D was increased to 2/5 pound in the later sprayings. Increasing the rate of 2,4-D acid used when corn was 10 to 18 inches high from 1/5 to 2/5 pound resulted in much better control of weeds and increased the yield 13 percent. Very slight improvement accompanied the increase in rate from 2/5 to 3/5 pound.

Tolerance of corn to 2,4-D.—Eighty corn inbreds, the 8 hybrids certified in Kentucky and the 12 single crosses used in making these hybrids were tested for their tolerance to both pre-emergence and post-emergence applications of 2,4-D at the Experiment Station farm at Lexington. Two pounds of 2,4-D acid in sodium salt applied at the rate of 15 gallons of

solution per acre was applied before the corn came up and 0.2 pound of 2,4-D acid in amine form in 6¼ gallons of solution per acre was applied as a post-emergence spray when the corn was 8-16 inches high. Poor weed control was obtained with the pre-emergence spray due to dry weather and the cloddy condition of the soil at the following planting. The corn in the post-emergence plots also suffered from competition with grass-type weeds not killed by the spray.

Nine inbreds in the pre-emergence test showed some type of injury or stunting while none of the hybrids or single crosses showed injury. Forty-six inbreds, 6 of the 8 hybrids, and all but one of the single crosses in the post-emergence plots showed response to 2,4-D in the form of fusion and proliferation of the brace roots and the development of root hairs on the brace roots. It is questionable whether this type of injury causes any serious reduction in efficiency of the plants.

Cost of using 2,4-D in corn production.—A study of the cost of treating bottomland corn with 2,4-D during the cultivation period was made in Henderson county in 1948. Average cost for labor, tractor, and equipment for applying the 2,4-D was $0.57 per acre, and cost for material was $0.60 per acre. The usual rate of application was one-half pint of 40-percent liquid preparation per acre and approximately 5 acres were treated per man-hour.

When added to the labor, power, and equipment cost of producing corn with medium tractor equipment, which was $18.80 per acre, the use of 2,4-D increased the average cost per acre 6 percent. However, if use of 2,4-D were substituted for one cultivation the cost per acre would be about the same.

Hybrid popcorn.—Tests of popcorn hybrids in commercial use in Indiana were continued at Lexington and Owensboro in comparison with South American and Supergold open-pollinated varieties. Yields at Lexington averaged 3,505 pounds of ear corn per acre, and at Owensboro 5,580 pounds. The hybrids yielded 9.6 percent more than the open-pollinated varieties at Lexington and 18.9 percent more at Owensboro. Purdue 31 was again the highest yielding hybrid in both locations and has been the highest yielding on the basis of 2- and 3-year averages at both locations. Over a 5-year period at Lexington Purdue 31 and Purdue 3 have had the highest average yields, followed by Purdue 38 and Purdue 32. Purdue 1 has also been high yielding at Owensboro.

Life history of the European corn borer.—Mortality of overwintering corn borers was light in 1948, averaging about 10 percent. Pupation began the first week in May and all borers had pupated by June 10. Moth emergence began by May 15, reached a peak on June 3, and was over by June 21. Weekly dissections showed that borer development was much more advanced in corn stubble or in debris in small-grain fields than in

standing shocks. On May 18, only 22 percent of the larvae had pupated in shocked corn and no moths had emerged, while in stubble, on May 17, 88 percent of the larvae had pupated and 12 percent of the moths had emerged. In corn debris, on May 19, 64 percent of the moths had pupated and 32 percent had emerged.

Egg laying began about May 25, when the earliest planted field corn was a foot tall, with the peak of egg deposition occurring on June 7. Egg laying by spring-brood moths was over by June 24, a time when earliest planted field corn averaged slightly over 4 feet in extended height.

First-generation larvae began hatching June 2, and in early sweet corn some borers were full-grown by the first of July. First pupation in early sweet corn occurred about July 3 and about July 10 in early field corn. Almost all (99 percent) of the first-brood borers pupated in 1948 to give rise to a second generation. This was similar to the percentage of pupation in 1944 and in marked contrast to the seasons of 1945, 1946, and 1947, when fewer than 45 percent of the borers pupated that same season. Attack by second-brood borer was light in Fayette county. Evidence was found in September of a very small third brood.

Observations on the biology of the corn borer indicate that the great reduction in corn borer population in the Inner Bluegrass Region in 1948 was due to a number of factors. General delay in the planting of corn, due to rainy weather early in May, coupled with unusually early moth emergence, plus cool evening temperatures at the time for egg-laying resulted in a small amount of first-brood borer. Hot, dry weather at the time of egg-laying by first generation moths was unfavorable for the development of second-brood borer. In Fayette county heavy attack by *Lydella* parasites was also an important factor in borer reduction.

European corn borer abundance.—A fall survey was made in 1948 to determine the abundance of European corn borer in 12 counties which had been studied in previous years. Five of the counties were surveyed by workers from the Federal Bureau of Entomology and Plant Quarantine. In general, the corn borer was found to be much less abundant in 1948 than in 1947, the decrease in the Inner Bluegrass Region being especially striking. In Woodford and Fayette counties, for example, borer populations fell from an average of 442 and 194 borers per 100 plants in 1947 to 60 and 40 borers per 100 plants in 1948. Corn borer populations remained at a high level in Jefferson county, averaging almost 2 borers per stalk in the entire county. The pest was exceedingly abundant in cornfields south and east of Bowling Green.

European corn borer parasites.—In 1948, 16,605 parasites of the species *Macrocentrus gifuensis* Ashm., furnished by the Federal Bureau of Entomology and Plant Quarantine, were released on a total of 10 farms in Jefferson county in an attempt to establish this exotic species in an area

where the European corn borer has become abundant. This made a total of 39,420 parasites which have been liberated in the state in recent years.

To date, the most promising imported parasite for the reduction of the European corn borer is a tachinid fly, *Lydella stabulans*, var. *grisescens* R. and D., which is now well established and spreading rapidly from release points in Fayette, Bourbon, Boyle, and Warren counties. Results of 1948 rearing work by the Federal Bureau of Entomology and Plant Quarantine with corn borers collected in the fall parasite survey of 1947 indicated that an average of 42 percent of the corn borers within a 7-mile radius of Lexington were parasitized by *Lydella*.

Parasite surveys were made in the fall of 1948 in Warren and Jefferson counties and at 10-mile intervals throughout much of the bluegrass region. It was found that *Lydella* had spread into Scott, Woodford, and Jessamine counties. Other information on parasites recovered and amount of parasitism will not be available until rearing work with the corn borers collected is completed in 1949 by the Federal Bureau of Entomology and Plant Quarantine.

Feeding on corn silks by adults of the northern corn rootworm, and effect on sterility.—For the past 2 years adults of the northern corn rootworm, *Diabrotica longicornis* (Say), have been unusually abundant in the bottomland cornfields of western Kentucky, and in some late fields have destroyed cornsilks almost as fast as they appeared. Fearing that loss of silks would result in sterility, many growers sprayed or dusted their cornfields with DDT, principally by airplane, to kill the adult beetles. Excellent control of the beetles was secured, but an examination of treated and untreated fields seemed to indicate that much of the sterility observed was due to genetic factors rather than to insect damage.

During 1948, tests were made in two fields of late corn, both heavily infested with northern corn rootworm adults, to find out, under controlled conditions, how much sterility was due to silk injury by the beetles. In each field, in late July, a number of ears were covered with plastic mesh bags to keep out the beetles, before silks had been injured, and about 25 beetles were enclosed. Mesh bags were used so that pollen could reach the ears. In other tests beetles were removed from ears on which the silks had been destroyed and the ears enclosed in mesh bags, while similar ears were covered with paper bags to see how much pollination had taken place up to that time.

Comparison of the sterility found on the various classes of bagged ears with that on unbagged ears whose silks were destroyed by the beetles showed that in these tests, under field conditions, beetles feeding on silks or beetles cutting silks caused little or no sterility. Also, counts made near Cadiz in adjacent plots, one sprayed with DDT to control rootworm adults and the other unsprayed, showed no significant decrease in sterility of the

sprayed corn and no significant increase in weight of grain produced on the sprayed corn.

Examination of mature ears which were enclosed in mesh bags before pollination had taken place, showed that pollination had proceeded normally. At Cadiz, the bagged single cross corns used to produce Ky203 seed had 7.4 percent sterility for the male (33-16x49) and 1.6 percent sterility for the female (27x122). Corresponding unbagged ears with silks injured by the beetles, had 11.3 percent and 6.4 percent sterility. At Lexington, 5 different kinds of open-pollinated corn had from 0.2 to 2.6 percent sterility when the uninjured, unpollinated ears were enclosed in mesh bags compared to 0.1 to 1.7 percent sterility where adults of the northern corn rootworm destroyed the silks on unbagged ears.

These results represent the experimental data obtained during one season on a few kinds of corn, and should not be considered as final or conclusive.

DDT-impregnated bags for protecting stored corn from insects.—DDT dissolved in carbon tetrachloride was used to impregnate cotton bags in which insect-free corn was stored. The bags were dipped in or sprayed with solutions containing 2.5, 5, and 10 percent of DDT. Four bags were dipped and four bags sprayed with each of the three solutions. Shelled corn was also stored in eight untreated bags. The treated bags were placed in contact with grain infested with the angoumois grain moth, the Indian-meal moth, the confused flour beetle, the saw-toothed beetle, the lesser grain beetle, and other insects. At the end of 6 months, the grain in all bags was examined to determine the percentage of grain infested. The average infestation of the corn in bags dipped in the 2.5 percent solution was 2.4 percent and in the sprayed bags 3.4 percent. There was 1.5 percent of infested corn in bags dipped in the 5-percent solution and 1.7 percent in the bags sprayed with the same solution. In bags dipped in the 10-percent solution, there was an average infestation of 1.2 percent and in bags sprayed with the same solution, an average of 1.6 percent of infested corn. The average infestation in the checks was 38.2 percent.

Breeding tobacco for resistance to wildfire.—Since this work was begun in 1946 the fourth back-cross generation of tobacco on tobacco crossed with *Nicotiana longiflora* (resistant to wildfire) has been grown. In most back-cross lines the number of resistant plants is very small, indicating a very unstable relation between *tabacum* chromosomes and the *longiflora* chromosome containing the resistance factor. In a few lines resistant plants have appeared in fairly high percentages, suggesting that crossing over has occasionally taken place between the *longiflora* chromosome and a *tabacum* chromosome. If this proves true the development of wildfire resistant varieties of both dark and burley tobaccos is assured.

Resistance of Nicotiana tabacum X N. glauca hybrids to streak virus.—Tobacco is very susceptible to streak. *N. glauca*, the so-called tree tobacco of the Southwest, is very resistant. The reaction of the first generation hybrid is intermediate: local lesions are fewer and develop more slowly than in tobacco; systemic infection develops more slowly and seems to be less severe. The resistance of back crosses with tobacco (after chromosome doubling by colchicine) is hard to evaluate or interpret. In advanced back-cross generations some lines appear to be more resistant than tobacco; when a large number of plants are inoculated the population becomes infected much more slowly, but the final disease in individual plants is rather severe. The resistance of *N. glauca* has not been successfully transmitted to tobacco.

Meadow nematodes and brown root rot of tobacco.—Brown root rot has been observed to be worse in seasons when there is considerable rain following setting of the tobacco crop. In 1948 a drouth followed setting and brown root rot was not evident. Plants on plots known to be heavily infested with meadow nematodes grew as rapidly as plants in soil known to have a very light infestation. Meadow nematodes were found in extremely small numbers in the roots of tobacco plants in infested soil. Evidently nematodes require free water in the soil in order to invade roots.

Reaction of species of Nicotiana to wildfire.—Fifty-eight species of *Nicotiana* have been described. Seed of eight of these is not available. Of the remaining 50 all except 3 have been tested for resistance to wildfire. The range of reaction in the species is from extreme susceptibility such as in *N. benavidesii* and *N. paniculata*, through moderate susceptibility such as in tobacco, to resistance such as in most plants of *N. longiflora*, *N. alata*, *N. plumbaginifolia*, *N. repanda*, *N. bonariensis*, and *N. arentsii*.

Tobacco streak virus in sweet clover.—Sweet clover is a natural host of the tobacco streak virus, but transmission to sweet clover has been difficult, and symptoms have not been described in detail. Inoculum prepared by crushing young leaves of vigorous systematically invaded plants of *Nicotiana rustica* with M/10 Na_2HPO_4 proudced local lesions on rubbed leaves of 57 of 75 inoculated sweet clover plants. The local lesions were mostly yellow spots 1 to 2 mm in diameter, often with a small dead center; some small dead spots and rings also occurred. On veins yellow spots tended to be elongate. Systemic infection first developed in the youngest leaf or leaves of the main shoot or lateral branches, chiefly as small yellow spots with tiny dead centers, or yellow bands along veins. Leaves formed later were sometimes dwarfed, sometimes pinched, often with large yellow areas or numerous yellow specks, at times faintly mottled, often with irregular margins.

Gas treatment of tobacco plant-bed soils.—Treatment of plant-bed soils with methyl bromide applied under a gas-proof cover before seeding

tobacco at the Experiment Station farm in the spring of 1948 gave effective control of weeds. Where the prepared soil was exposed for 72 hours to methyl bromide gas used at the rate of 1 pound of the liquid per 100 square feet of bed and the tobacco seeded shortly afterward, an excellent stand of plants resulted, and hand weeding was not required. On an untreated section of the same bed weeds smothered the tobacco within a few weeks' time. Additional tests begun in the fall of 1948 indicate that 1 pound of mthyl bromide per 100 square feet of bed for an exposure period of 24 hours or ½ pound for 48 hours will give good kill of weed seeds in well-prepared soils when temperatures range from 60 to 70 degrees or higher.

Either plastic-coated fumigating tarpaulin or two-ply building paper which has reinforcing fibers cemented between the two sheets with asphalt, was satisfactory as a covering for the gas treatment. The covering was supported 10 to 12 inches above the bed, and the edges sealed to the ground with soil. The methyl bromide gas effectively penetrated well prepared soils to a depth of 6 inches, as indicated by the absence of all weed seed germination in a weedy soil treated first then layers of soil exposed to depths of 2 inches, 4 inches, and 6 inches, and kept in the greenhouse under favorable growth conditions for several weeks.

Control of wireworm injury to newly set tobacco plants.—Benzene hexachloride and chlordan were used as soil insecticides in the spring of 1948 to control wireworm injury to newly set tobacco plants. The chemicals were mixed with screened soil, broadcast on the plots, and disked into the soil 3 weeks before the plants were set. The benzene hexachloride was used at rates of 1, 2, and 3 pounds of the gamma isomer per acre and the chlordan at rates of 2½, 3½, and 5 pounds per acre. There were five replications of each treatment and five untreated plots.

In the untreated plots an average of 19.7 percent of the plants were injured. In plots where benzene hexachloride, 1 pound gamma isomer was used, there were 75.6 percent fewer plants injured than in the untreated plots; where 2 pounds gamma isomer was used, there were 81.7 percent fewer plants injured; and where 3 pounds of the gamma isomer was used, 80.7 percent fewer plants were injured. Where chlordan at 2½ pounds per acre was used, 55.7 percent fewer plants were injured than in the untreated plots, and for the 3½ pounds 70.5 percent fewer plants were injured.

Effect of varying rates of application of nitrogen on yields of burley tobacco.—At the Campbellsville, Mayfield, and Greenville experiment fields, burley tobacco is grown on plots where the amount of nitrogen fertilizer applied is varied. Each plot receives superphosphate at the rate of 60 pounds of P_2O_5 and sulfate of potash at the rate of 60 pounds of K_2O per acre. No manure is used, but all plots have been limed.

On each field tobacco follows grass and legumes. The average yield for the three fields for the 1945, 1946, and 1947 tobacco crops on the plots to which no nitrogen was added, was 1,177 pounds per acre. Plots receiving 30 pounds of nitrogen averaged 1,319 pounds, those receiving 60 pounds, 1,448 pounds, and those receiving 90 pounds, 1,579 pounds. In these experiments yield of tobacco was increased somewhat over four pounds per acre for each pound of nitrogen applied.

Effect of time of application of nitrogen to green-manure crops on yield and value of burley tobacco.—The addition in March of 100 pounds of nitrogen per acre to a barley-vetch green-manure crop lowered yield of burley tobacco by over 200 pounds per acre and lowered gross receipts by $150 per acre, as compared with a similar green-manure crop that did not receive nitrogen until the time of plowing in early May, when an equal amount of nitrogen was applied and turned under. Likewise this amount of nitrogen applied to a barley green-manure crop in March lowered the yield of tobacco over 200 pounds and value $135 per acre, compared with a similar crop which received the same amount of nitrogen at time of plowing. Fifty pounds of nitrogen applied at the time of plowing under a barley-vetch cover crop was more effective than the 100-pound application of nitrogen to the barley and vetch in March. Comparing the barley-vetch with the barley alone, as a green-manure crop, yield and value of tobacco were increased by the vetch when no nitrogen or 50 pounds per acre was applied, but not when 100 pounds was applied. The above results were averages of one set of treatments in 1946 and duplicate treatments in 1947.

Time of cutting and priming burley tobacco.—In 3 years of experiments (1945-47) on time of cutting burley tobacco, the stage of maturity of the plants at harvest had a direct effect upon income, but little effect upon labor requirements. Maximum yields occurred when cutting was at the time the daily growth in the top of the plant equaled the daily loss of lower leaves, or at the time the plant was about 90 percent ripe. Quality (average price) increased approximately 14 percent from early to late harvest. Tobacco cut early during the three years averaged $712 gross income per acre; mid-harvest cutting (the time when the farmer usually cuts) $821 per acre; and late cutting (ripe) $843 per acre.

Priming once (three leaves primed per plant) eliminated 40 percent of the total loss of lower leaves in normal growing seasons (1945 and 1946). Two primings in the same years (average 6.5 leaves primed per plant) eliminated all the loss of lower leaves. In 1947 (a more humid season than in 1945 or 1946) three primings were required to eliminate all loss of lower leaves. The average loss of lower leaves in unprimed tobacco in 1947 was 29 percent of the total growth as compared to 12 percent in 1945-46.

In any of the three years 1945-47, either one or two primings yielded returns well above the cost of additional labor. Returns for additional primings, however, were either very low or uneconomical. The average per-hour return for additional labor required to prime tobacco were as follows: one priming, $1.35; two primings, $1.78; three primings, $1.12; and four primings, $0.77.

Labor used in looseleaf tobacco warehouses.—An average of about 45 minutes of labor is used in Kentucky sales warehouses to market a 350-pound basket of burley tobacco, according to studies made in several warehouses during the 1947-48 marketing season. Of this time, 83 percent was used in receiving and packing the tobacco preparatory for sale. Nine percent was used in moving tobacco on the floor and about 8 percent was used to ship the tobacco out.

Not all of this labor is furnished by warehouse operators. The farmer, or the truckman whom he hires, usually is responsible for unloading the truck, sorting the tobacco when necessary, reloading the sticks, and such. This work requires an average of about 10 man-minutes for a basket holding 40 sticks of tobacco. When tobacco was loaded out to the buyer, about 3 man-minutes per basket were used, part of which was furnished by the warehouse and part by the trucker.

The time used in packing a 40-stick basket varied with the methods used, the condition of the tobacco, and the distance the basket was placed from the truck or pile. The average packer handled about 4 sticks per minute, but some packed 6 sticks per minute with apparently no greater effort.

When tobacco was shipped out of the warehouse by truck, using a steel plate to bridge the gap between truck and platform saved about 2 man-minutes per basket, compared with the more common practice of sliding the basket from a duckbill. For a warehouse which holds 2,000 baskets, the use of a steel plate therefore would save between 60 and 70 hours of labor at each full sale.

Stick-sorting of tobacco at the warehouse considerably increased the time used by the farmer, the trucker, and the warehouse employees to unload and pack the tobacco. By sorting tobacco properly at the farm, growers can know the number of sticks to go on each basket and thus reduce the amount of handling in unloading at the warehouse. Less handling means less loss to the grower from shattering of leaves.

Growth and mineral composition of burley tobacco grown in different parts of the state.—Burley tobacco was grown under comparable fertilizer conditions at London, in Laurel county, and at Lexington. The London soil is a very low phosphate soil, probably Tilsit silt loam. The Lexington soil is the high-phosphate Maury silt loam. Nitrogen was used at two different levels, phosphorus at four, and potassium at two. Potash

was supplied to different plots in the form of muriate, of sulfate, or as Sul-po-mag. Growth of the crop in the Laurel county experiment was influenced markedly by fertilizer treatment, particularly by nitrogen and phosphates, and to a lesser though important extent by potash. At Lexington different treatments had no important effect on growth.

The calcium and iron content of the crops from the two locations were about the same. Magnesium and nitrogen were considerably higher at Lexington than at London, but potassium, phosphorus, and chlorine were significantly higher in the crop from the London experiment than in that from Lexington. At both fields potash and magnesium fertilizers increased the content of potassium and magnesium in the plants while at London phosphate fertilizers had the same effect. Perhaps the most striking effect on both fields was the increase of chlorine in the tobacco produced on plots receiving part or all of the potash fertilizers in the muriate form. The chlorine content of the leaf was increased approximately four times.

Tomato varieties.— The trial planting in 1948 consisted of 57 varieties, mostly unnamed and unintroduced selections from the breeding laboratories of the Southern Cooperative group and the Virginia Experiment Station. Valiant and Garden State were used as standards. A few of the unnamed selections showed much promise, and if they continue outstanding in further trials they will be introduced for public use.

Effect of low-level radioactive materials on growth of tomatoes.— An experiment planned to test the effect of low level radioactive materials on tomatoes was conducted in 1948 in cooperation with the U. S. Department of Agriculture and the Atomic Energy Commission. Soil treatments were made with commercial radioactive products and radium. The results obtained from this study failed to show any beneficial effect on the growth or quality of the tomato crop.

"Split applications" of nitrogen for lima beans.—Lima beans are particular about the amounts of nitrogen they get and when they get it. In this test the following acre-yields of green pods and beans were obtained:

Treatment	*Early Yield*	*Total Yield*
	lb	*lb*
No nitrogen applied (check)	147.5	4,374
400 lb N at start	178.4	4,789
200 lb N at start and 200 lb N after bloom	196.2	4,808

When all the nitrogen was applied at the start a good increase was obtained, but when the same amount was split and applied half at the start and half just after blooming, the yield (especially the early yield) was increased still further.

Bean beetle control.—Last year a new insecticide for bean beetle control, an analog of DDT which is 50 percent Methoxychlor, looked good

in limited trials. This year it was tried more extensively and was very effective. The untreated beans were almost completely eaten up, while two dustings, 15 pounds 50 percent Methoxychlor in 85 pounds of commercial talc, gave complete control. The beans greened up and seemed to grow better after treatments. Bean leaf hoppers also were controlled and the rapid spread of rust seemed to be prevented. Lima beans were sprayed with 2 pounds 50 percent Methoxychlor in 100 gallons of water, and good control was obtained.

Sweet corn varieties.—Sixteen varieties from the Southern Cooperators on Sweet Corn Varieties were planted in early May for the replicated trials. Rains came in July in time to make a fair yield although early June was very dry. Hybrid Stowell's Evergreen produced the largest ears and the largest yield of corn, but was 9 days later than Golden Cross Bantam. Golden Security was the next in yield with medium large ears. Of the earlier types, Tendermost was best but was not nearly as productive as Hybrid Stowell's Evergreen. It also had large ears for an early variety. Tristate was nearly as productive as Tendermost and had the largest ears of the early sorts, being nearly as large as Hybrid Stowell's Evergreen.

Potato varieties.—Seven new varieties of potatoes developed for New York were tested for yield in Kentucky. Acre-yields, in bushels, were as follows: Snowdrift, 288; Fillmore, 232; Chenago, 218; Essex, 184; Placid, 169; Virgil, 123; and Empire, 104. Average size of tuber ranged from 0.186 lb for Essex to 0.152 lb for Fillmore. Snowdrift, Chenago, and Essex were smooth; Fillmore, fairly smooth; Empire, medium; and Virgil and Placid, rough. The potatoes were planted May 30, and harvested September 15. Drouth prevailed during most of the growing season.

Some preferences of Louisville consumers for sweetpotatoes.—To discover certain consumer preferences for sweetpotatoes, 1,160 purchasers of sweetpotatoes were interviewed in 16 Louisville stores in different income areas during a 4-week period. Forty-three percent of all sweetpotatoes bought were home-grown Porto Ricos, 33 percent were shipped-in Porto Ricos, and 24 percent were home-grown Nancy Halls. Fewest Nancy Halls were sold in the above-average income areas, and most in the lowest-income area, which had a large colored trade. Buyers under 25 years of age bought a higher percentage of Porto Ricos than buyers above 50 years old.

Reasons given for the choice of Porto Ricos were sweeter taste, superior flavor, more moist and juicy, cooks better, preferable color, and a better appearance on the table. Reasons for choosing Nancy Halls were preferable flavor, cooks better, mealier and drier, lighter color, not so sweet, and lower price.

Eighty-two percent of the sweetpotatoes purchased during the period were to be either baked or candied, another 10 percent were to be fried while minor uses were for boiling, for pies, or for mashing. Nearly 80 percent purchased just enough sweetpotatoes for one meal, usually one for each member of the family. The important point made by nearly all purchasers in selecting sweetpotatoes for any use was to have them uniform in size, smooth, and free from cuts and bruises. The medium-sized sweetpotato was preferred for all uses.

Allyl alcohol for weed control in gardens.—Most of the weed controls now used, especially 2,4-D, are not safe in a vegetable garden. In testing for a safe treatment, allyl alcohol was applied at the rate of 2 cc to 1 pint of water per square foot of soil area. The area had been worked up for several days. Crab grass and other weeds were coming thickly. The solution was put in a sprinkling can and sprayed in rows 3 feet apart, the width sprayed being about 6 to 8 inches directly over the row to be planted. In 3 days the surface weeds were killed and beans were planted with a drill in the center of the 6-inch row area, 3 feet apart, leaving 3 inches of treated soil on each side of the rows and 30 inches of untreated area between the treated areas. The beans came up rapidly and no weeds came in the row during the crop. A good crop was harvested. The weeds in the untreated area were easily controlled by cultivation. Even after the crop was made and the vines plowed under, few weeds came in the treated areas as compared with those in the untreated areas.

Orchard spray service.—Information was disseminated by this service through copies of seven spray letters sent to 2,965 Kentucky commercial fruit growers and to county agents.

Peach varieties.—Among important new peach varieties, Erly Red Fre, Redhaven, Fair Beauty, Triogem, Red Rose, Ambergem, Veteran and Sullivan Early Elberta were reported as performing satisfactorily in several parts of the state. In 1948 the first fruits were produced on trees top-worked in commercial orchards to the following very new and potentially important varieties of peaches: Fairhaven, Southland, Bray Early Elberta, and Michigan 125.

Peach pruning.—In the cooperative peach pruning tests at Henderson the following yields on 11-year-old Elberta trees were obtained: modified leader, 9.3 bu; open center, 9.3 bu; converted from modified to open center, 9.9 bu; non-pruned, 11.2 bu; and pruned for the first time in 1948, 6.6 bu. These figures show the modified leader, open center, and converted trees to be now virtually together in yield. The size of fruit was also virtually the same, at about 160 peaches per bushel. The non-pruned trees still showed a slightly larger yield but the trees had such great spread that they overlapped and were badly overcrowded. A tree

that received its first pruning at the start of its eleventh year in 1948 produced 6.6 bushels of peaches, averaging only 128 per bushel—an excellent yield of large fruit.

Insects and diseases affecting peaches.—A harvest survey was made in nine western Kentucky peach orchards to determine the insects and diseases responsible for damage to the ripening fruit and to determine the general effectiveness of benzene hexachloride and chlordan spray schedules as compared with the standard lead arsenate schedule.

Injury to fruit by second-brood oriental fruit worm was unusually severe in 1948 regardless of the spray schedule used. In one Mayfield orchard 33.3 percent of the crop had early injury. Injury by third-brood oriental moth was slight in orchards where lead arsenate schedules were used but reached outbreak proportions in orchards where benzene hexachloride and chlordan schedules were followed. In two Paducah orchards, 29.1 percent and 46.0 percent of the crop suffered late oriental moth injury where these materials were used and, in addition, brown rot caused considerable loss.

Curculio control was unusually good in seven of the nine orchards surveyed, in spite of the unusually large number of over-wintering adults. Injury from "cat-facing" bugs was unusually light this year probably due in some cases to the inclusion of DDT or benzene hexachloride in early sprays.

Spotting of foliage and fruit by *Bacterium pruni* was unusually prevalent this season. In the substation peach orchard at Princeton, where five different spray schedules were tested, this disease seriously affected 29.5 percent of the fruits in parathion sprayed plots, 17.1 percent of the fruits in chlordan sprayed plots, 16.0 percent of the fruits in plots sprayed with chlordan and benzene hexachloride, and 15.6 percent of the fruits in plots sprayed with benzene hexachloride. In contrast, only 3.2 percent of the fruit was badly spotted in plots sprayed with the standard lead arsenate schedule.

Strawberry varieties.—Tennessee Shipper (248 crates per acre) and Tennessee Beauty (217 crates per acre) out-yielded all other varieties in the test, among those of shipping quality. The berries of these two varieties were large, firm, and attractive. Tennessee Supreme ranked between the other Tennessee varieties in yield, and the berries were large and attractive but too soft for shipping. It appears to be an excellent variety for the home garden and local market. Robinson was next in production at the rate of 208 crates per acre and merits further testing. Temple produced a low yield due to its habit of forming few runner plants. Fairfax, a high-quality home berry, also produced a low yield. The well-known varieties Blakemore, Premier, and Catskill produced at the rate of 167, 191, and 169 crates per acre, respectively.

Strawberry varieties resistant to red stele.—Strawberry plants of the Fairland and Temple varieties were distributed for trial in Campbell county, around Louisville, and in the Paducah section in western Kentucky. These two varieties are resistant to the red stele root rot, which has been found in the above three sections of the state, as well as at Lexington.

Nitrate nitrogen content of soil under strawberry mulches and cropping systems.—Soil nitrate determinations were started on April 25 and were continued at weekly intervals through May and June, on soils under ten different mulching and cropping treatments. The average nitrate nitrogen content of soil under straw mulch was lower than with any other treatment except bluegrass sod. The average nitrate nitrogen content (ppm) of soil under the various treatments was as follows: rock wool mulch, 40; rock wool mulch + sodium nitrate, 45; fiberglas mulch, 60; fiberglas mulch + sodium nitrate, 128; paper mulch, 51; straw mulch, 36; bluegrass sod, 31; bare ground, 34; barley cover crop, 39; and sweet clover and soybean cover crop, 54.

Control of strawberry weevil.—For several years the strawberry weevil, *Anthonomus signatus* Say, has been on the increase in the Bowling Green and Purchase strawberry-producing areas. In tests this season near Sharpe, Kentucky, 5 percent chlordan dust gave excellent control of the weevil and doubled the size of the crop.

Plots were laid out in a Blakemore patch where strawberry weevil caused extensive damage in 1947. On April 9, shortly after weevils began cutting buds, several plots were dusted with 5-percent DDT dust, several were dusted with 5-percent chlordan dust and other plots were left untreated. Counts a month later indicated that chlordan gave excellent control (17 percent of the buds cut) compared to no control in the DDT (49.4 percent of the buds cut) and check plots (48.5 percent of the buds cut).

Effect of 2,4-D on strawberries.—For weed control in nine strawberry varieties, 2,4-D as amine salt (40-percent liquid, 1000 and 2000 ppm) and as 95-percent sodium salt (1000 ppm and 2000 ppm) was applied immediately after the first-year harvest.

In all the varieties treated, injury to plants occurred at the dilution rates used. However, less injury occurred from use of the 95-percent sodium salt than from the 40-percent amine salt. Robinson and Catskill were particularly susceptible to injury and Tennessee Shipper was more susceptible than either of the other two Tennessee varieties. Injury of Blakemore, Tennessee Beauty, Premier, Tennessee Supreme, and Tennessee Shipper from the use of sodium salt at 1000 ppm was not serious enough to reduce the stand of plants to the point where yields for the coming season would be materially affected. With the varieties which

set runner plants prolifically a reduction in number of new plants may be desirable.

Black raspberry varieties.—The yield of black raspberries for the summer of 1948 was considerably below that of 1947. This season Quillen yielded at the rate of 0.93 pints per hill and at the rate of 96.44 24-pint crates per acre. The same area in 1947 yielded at the rate of 3.54 pints per hill and 367.12 24-pint crates per acre. Morrison variety averaged 1.48 pints per hill and 153.84 24-pint crates per acre, while the same area in 1947 yielded 3.42 pints per hill and 354.68 24-pint crates per acre. In quality and attractiveness Morrison is more desirable than Quillen, although Quillen appears somewhat less susceptible to anthracnose.

Intake and nutritive value of forages consumed by grazing steers.—Eight grade Hereford steers were permitted to graze, in groups of four, for 2-week periods, on a variety of pure forages. On basis of average daily dry-matter intake, the forages ranked as follows (highest to lowest): Ladino clover, alfalfa, orchard grass, Ky 31 fescue, and Kentucky bluegrass. For the Ladino clover, average daily intake of dry matter was 27.7 pounds. For Kentucky bluegrass the respective figure was 15.5 pounds. On basis of organic matter digestibility the forages ranked as follows (highest to lowest): Ladino clover (85.6), Ky 31 fescue (73.1), Kentucky bluegrass (71.8), alfalfa (71.6), and orchard grass (71.3). On basis of digestible protein content, the rapidly-growing young forages ranked as follows: Ladino clover (22.7), alfalfa (16.2, bluegrass (15.3), orchard grass (13.0), and Ky 31 fescue (11.0). Forages tested in more slowly growing condition had digestible protein content as follows: Orchard grass (10.2), bluegrass (7.3), Ky 31 fescue (7.2).

Nutritional value of fresh forages fed to steers and wethers in digestion and metabolism trials, and consumed by them in grazing.—Five metabolism trials using three wethers in each and one digestion trial using three steers were conducted. The average digestibility of lignin by wethers was—15 percent and by steers—9 percent. These figures obtained when fresh forages were fed to the experimental animals indicate a possible corresponding error in the determination of intake of forages by grazing animals, since in the latter determination the intake is calculated from lignin excretion upon the assumption that lignin in feed is 100 percent excreted. Digestion coefficients for the fed forages were determined conventionally and by use of the lignin-ratio technique. Those determined conventionally were lower than the latter and corresponded more closely to coefficients determined by lignin ratio for grazing animals. It was found that digestible nutrient content decreased regularly as lignin content of the forage increased, and that the average metabolizable energy content of the forages amounted to 73.8 percent (range 71.6 to 75.8) of the

digestible energy content of the forage. This was irrespective of the stage of maturity of the forage or of the type of forage.

The following regression equations, standard errors, and correlation coefficients illustrate the relationship existent in our data from 17 grazing trials with wethers and 9 with steers, between (a) lignin content and organic matter disgestibility, (b) lignin content and protein digestibility, and (c) protein content and organic-matter digestibility.

a.	$Y = 100.2 - 5.40x$, $Se = 3.11$	$r = -.92$	(wethers)
	$Y = 97.6 - 4.19x$, $Se = 2.06$	$r = -.98$	(steers)
b.	$Y = 99.6 - 5.28x$, $Se = 5.23$	$r = -.81$	(wethers)
c.	$Y = 55.8 + .90x$, $Se = 6.05$	$r = .66$	(wethers)

Intake and nutritive value of forages eaten by grazing wethers.—A total of 21 yearling wethers and wether lambs, in groups of 3, were permitted to graze, in 2-week periods, a total of eight forages in 17 grazing trials. In trials conducted on young, rapidly-growing forages the average daily pounds of dry matter intake, percent organic matter digestibility, and percent digestible protein content were as follows (forages ranked in order of decreasing dry matter intake): Ladino clover (4.32, 79.2, 17.9), bluegrass (3.51, 75.4, 14.5), Lincoln bromegrass (3.22, 82.5, 18.9), alfalfa (3.17, 81.4, 27.2), orchard grass (3.17, 77.5, 15.7), timothy (2.96, 77.2, 12.0), Ky 31 fescue (2.74, 79.0, 15.8), red top (2.19, 65.5, 8.8).

In trials conducted on more mature forages the corresponding data were: alfalfa (3.29, 69.7, 14.4), Ladino clover (2.92, 65.9, 14.4), orchard grass (2.46, 64.3, 10.1), Lincoln bromegrass (2.39, 66.5, 10.3).

Supplemented cottonseed hulls in feed for sheep.—Three groups of 10 Western lambs each were placed on feeding trial at an average weight of 65.5 pounds per lamb. Group I received a ration of 45 percent alfalfa hay and 55 percent cracked corn. Group II received a ration of 30 percent cottonseed hulls containing 10 percent molasses, 51 percent cracked corn, 15 percent cottonseed meal, and 4 percent alfalfa meal. Group III received a ration of 28 percent cottonseed hulls without molasses, 56 percent cracked corn, and 16 percent cottonseed meal. All groups received ground limestone and salt at will. The lambs were given all the feed they would eat up to 2.8 pounds daily. Lambs of groups II and III required a month to reach full feed, while group I lambs reached full feed within a week. During the latter half of the trial, the group III lambs did not consume their full allowance of feed. The summarized data were:

	Group I	*Group II*	*Group III*
Lambs per lot	10	10	10
Days on feed	98	105	112
Average initial wt (lb)	65.4	65.5	65.5
Average final wt (lb)	104.6	99.7	86.0
Average daily gain (lb)	.400	.326	.183
Average daily feed (lb)	2.76	2.53	1.67
Pounds feed per lb gain	6.90	7.75	9.13

Early death of embryo as a factor in conception rate in sheep.—In order to determine whether early death of the embryo is an important factor in the low conception rate of ewes bred early in the breeding season, 60 yearling mottled-faced northwestern ewes were artificially inseminated with undiluted semen from purebred Southdown rams during the period September 9 through October 18, 1948. Thirty of the ewes were slaughtered the third day after insemination, and the ova recovered from the reproductive tracts and examined for fertilization as evidenced by normal-appearing cleavage. The remaining thirty ewes (control group) were checked daily for return to estrus, with a teaser ram, for a period of 60 days after the last ewe had been inseminated.

The results indicated that early embryonic death was not an important factor in reducing conception in this group of ewes. Thirty-seven percent of the ewes in the slaughtered group yielded one or more normal-appearing fertilized ova; and in the control group 37 percent of the ewes did not return in estrus and this same percentage subsequently lambed. A positive but non-significant correlation was found between estimated motility of the sperm and fertility.

All ewes in the slaughtered group had ovulated. Thirty percent of the total number of ova recovered were fertilized, 52 percent were normal appearing one-celled ova, and 18 percent were classified as abnormal on the basis of empty or broken zonae pellucidae or disintegrating cells.

Ewes as sources of worm infection of lambs.—A group of five Southdown and five Hampshire ewes were examined at weekly intervals, beginning in early March, for a record of their worm-parasite infections. The weekly egg counts, which reflect total parasite burden, were found to increase rapidly in March and reached a first peak in mid-April, when the 10 ewes had an average count per gram of feces of 17,429 roundworm eggs. The range for individual ewes was 3,200 to 50,400 eggs. A second peak was reached in early May when the average count was 10,430 eggs, with an individual range of 400 to 32,140 eggs. Acceleration of peak intervals was successfully interrupted by a phenothiazine drench.

The weekly records demonstrated the need for medication of ewes earlier in the year, in order to protect lambs from heavily contaminated late spring pastures.

Winter survival of worm parasites of sheep on pasture.—A plot of permanent pasture measuring 60x70 feet and containing bluegrass, wild grasses, and white clover was contaminated with feces of parasitized ewes during October and November. The feces contained eggs of *Haemonchus contortus*, *Oesophagostomum columbianum*, *O. venulosum*, *Trichostrongylus* sp., *Ostertagia circumcincta*, *O. trifurcata*, *Nematodirus spathiger*, *Chabertia ovina*, and segments of the tapeworm *Moniezia expansa*. Three weeks of exposure on the plot in April, 5 months after

contamination, were sufficient to establish worm-parasite infection in four lambs previously free of parasites. The species of parasites demonstrated to survive winter conditions in Kentucky were *H. contortus*, *O. circumcincta*, *O. trifurcata*, *N. spathiger*, *C. ovina*, and *M. expansa*.

Blood picture of lambs infected with Nematodirus spathiger (Railliet, 1896) Railliet and Henry, 1909.—A 6-months-old parasite-free lamb was given infective larvae of *Nematodirus spathiger* by means of a stomach tube. It was exposed again 34 days later. Thirty-eight days after the second exposure the egg count showed 100 eggs/gm of feces. Twelve days after the second exposure, the lamb showed inappetence and depression which lasted for 3 days. At this time the MCHC (mean corpuscular hemoglobin concentration) dropped 2 percent and remained at this lower level 18 days then returned to the preinfection level of 31 percent. There were no significant changes in the white-blood-cell counts or differential counts, although there was a slight increase in the number of eosinophils 18 days after the lamb showed inappetence and depression. These data indicated a slight anemia in the lamb during the period of development of *N. spathiger* from fourth-stage larva to sexual maturity.

Blood picture and growth of lambs infected with tapeworms.—Two 6-months-old parasite-free lambs weighing 69.5 and 69 pounds, respectively, were exposed to cysticercoids of *Moniezia expansa*. One lamb was given 5 cysticercoids, the other lamb 60 cysticercoids. The exposed lambs were weighed daily. Proglottids of *M. expansa* were recovered from both exposed lambs 47 days after exposure. The lamb which received 60 cysticercoids scoured 31 days after exposure and gained only 10.5 pounds over a period of 57 days. The lamb which received only 5 cysticercoids gained 15 pounds in the same interval.

The only observed change in the blood picture of the two lambs was a drop of 3.2 percent in MCHC (mean corpuscular hemoglobin concentration) just prior to the first lamb's scouring. Twenty days after the lamb scoured, the MCHC had not returned to the preinfective level.

Tapeworms in spring lambs.—Deaths of sheep due to infection with the tapeworm *Moniezia expansa* were diagnosed in 11 flocks in central Kentucky. Greatest losses occurred in late May and were 60- to 80-pound lambs. In one flock several ewes died of such infection in late May.

One symptom of infection was a stiff gait; some lambs were actually down in the hindquarters. Diarrhea was characteristic of chronic cases; in acute cases animals died suddenly while in apparently good condition. The post-mortem data indicated that medication for sheep parasites should include treatment for tapeworms.

Blood picture of lambs infected with trichostrongyles.—A 6-months-old parasite-free lamb was given infective eggs of trichostrongyles by means

of a stomach tube. Periodic fecal examinations demonstrated light infection 27 days later, at which time the lamb was given more infective eggs. Fifty-four days after second exposure, egg counts showed 150 eggs/gm of feces.

The observed change in the blood picture was a drop of 1.5 percent in the MCHC (mean corpuscular hemoglobin concentration) 57 days after the second exposure. Seven days later (64 days after second exposure) the MCHC had reached the preinfective level. The drop in MCHC coincided with the peak in the egg count.

Oribatid mite hosts for the sheep tapeworm, Moniezia expansa.—From August to October, 1948, oribatid mites were collected from a pasture where sheep had grazed for a number of years. The mites were maintained in small jars containing moist filter paper and the cultures were inoculated with eggs from the terminal proglottids of *Moniezia expansa*. Cysticercoids were recovered from these mites three months later. Of 170 mites of the species *Galumna virginiensis* dissected, 58 or 34.1 percent were infected with cysticercoids. The number per host was distributed as follows: 1 cysticercoid in 22 individuals, 2 in 21, 3 in 9, 4 in 3, and 5 in 1 individual.

Of 77 *G. virginiensis* collected from a sheeep pasture heavily seeded with feces of sheep infected with this tapeworm, as well as seeded with proglottids of *M. expansa*, 2, or 2.5 percent, contained cysticercoids.

Serum levels of streptomycin in sheep.—A serum level of streptomycin can be maintained within closely defined limits by intramuscular injection at 3-hour intervals. Doses of 0.5 mg/lb of body weight maintained a concentration between 2.0 to 4.0 units/ml of serum, doses of 1.0 mg/lb between 4.0 and 8.0 units/ml of serum, and doses of 2.0 mg/lb between 8.0 and 16.0 units/ml of serum. Serum levels for the first 3 hours following the first injection were usually half the established level after several doses were given.

Advantages and disadvantages of milking room and rest shed as compared with stanchion-type dairy barn.—Average work methods and building arrangements for the walk-through milking room reduce time and travel in dairy chores about 50 percent from the usual conventional dairy barn requirements. Further savings may be made in improved work methods and building arrangements for the walk-through milking room. With proper storage of feed, conveniently arranged controls for the doors, and use of rapid milking procedure, the dairy chores per cow in the walk-through milking room can be further reduced from about 75 man-hours annually to about 50 man-hours. Other factors favorable to the use of milking room and rest shed are: (1) reduced cost of dairy barn; (2) complete housing of manure until spread on field; (3) reduced stanchion equipment; (4) reduced area for daily cleaning; (5) greater comfort for

cows; and (6) greater housing flexibility for shifting from one kind of livestock to another.

Major disadvantages are: (1) more than twice as much straw is needed for bedding; (2) "bossy" cows are more of a problem; (3) the herd cannot be as well displayed in the rest shed area as in a stanchion area; and (4) some artificial heat is required for the milking area in cold weather, since the animal heat of the cattle is not as well utilized for heating the walk-through milking room as in the conventional stanchion barn.

While more bedding is required in the rest shed than in the conventional barn, the better protection of manure by being under a roof until spread on the field and the absorption of liquid manure that is otherwise lost, adds plant food nutrients valued at over $17 per ton of straw, with nitrogen valued at 12.0 cents a pound, phosphate 16.3 cents a pound, and potash 8.6 cents a pound.

Hay feeding to dairy cows on pasture.—No appreciable increase in milk production or body weight resulted from feeding alfalfa hay free-choice to milking Holstein and Jersey cows on pasture during a 45-day experimental period from July 17 to August 30, 1948. Two experimental groups of 5 cows each received hay and were compared with a third 5-cow control group not receiving hay, while grazing on orchard grass-alfalfa pasture. Not over 20 percent of the herbage consisted of alfalfa. Grazing followed harvest of the early spring growth for silage and hay. Hay consumption ranged from slightly less than 6 pounds per head daily during the first 13 days of the experiment when receiving first cutting alfalfa hay to slightly more than 14 pounds during the last 32 days of the experiment when second cutting alfalfa was fed. Relatively dry weather during the last two weeks of the experiment caused the pasture herbage to appear dry and lacking in succulent growth. In spite of this the group not receiving hay produced as well as the groups receiving hay during this period. All three groups produced at a lower level than 10 comparable cows within the regular station herd grazing bluegrass pasture. Besides the difference in pasture this latter group had access to more ample shade than was available to the three 5-cow groups.

Using Brown Swiss bulls in grading-up scrubs.—Records now available after 6 years of experimentation show lifetime 305-day mature equivalent records of the five foundation scrub cows, ranging from 140 to 230 pounds of butterfat and averaging 176 pounds, per lactation. The first six ½-blood Brown Swiss daughters of these scrub cows have produced from 301 to 356 pounds, and averaged 325 pounds of butterfat. All told, the five foundation scrub cows have dropped nine ½-blood Swiss heifers. Six of these heifers have dropped a total of ten ¾-blood heifers. During this past year the first ⅞-blood (third cross) Swiss heifer was

born. All of the original scrub cows have been disposed of and their offspring now form the nucleus of the herd.

Artificial breeding program.—During the fiscal year ending July 31, 1948, the Kentucky Artificial Breeding Association bred 23,320 cows artificially. Of these, 40 percent were bred to Jersey sires, 36 percent to Holstein, and 24 percent to Guernsey. Twenty-six percent of the services were to proved bulls. Breeding efficiency was excellent in all three breeds; 68 percent did not return for second service within 90 days. Twenty-five bulls were in the state stud at the close of the year; seven were removed during the year due to low conception, sickness, or other reasons. Twenty-four local cooperatives received semen four times a week. At the close of the year there were 4,834 herd owners with 43,520 cows signed up in the program, about 7 percent of the dairy cattle in Kentucky. In areas having artificial breeding cooperatives, about 14 percent of the dairy cattle were bred artificially. These areas contain about 25 cows per square mile as compared with about 15.5 for the state as a whole.

The Experiment Station gave four short courses in which 48 men were trained to do artificial insemination work.

Breeding efficiency of heifers and of cows.—In a study of the records in 8 local cooperatives it was found that of 500 heifers, 58 percent apparently conceived at first service. This was nearly 10 percent lower efficiency than was obtained with cows which had had one or more calves. Cows bred less than 5 weeks after calving had a 48-percent conception rate, whereas cows fresh 2 to 3 months had a 66-percent conception rate.

Evaluation of dairy-bull semen by incubation.—Three hundred twenty-five samples of diluted semen obtained in the artificial breeding program were incubated at 100° F to determine how long sperm would stay alive at body temperature. The incubation time was correlated with the conception rates in the field, as tabulated by ejaculate. This correlation was found to be $0.84 \pm .03$ and was highly significant. In several instances the incubation information gave good indication of conception rates when other estimates of quality did not indicate such. The incubation method of evaluating semen would seem to be of considerable value in artificial insemination work.

Bluegrass pasture for chickens.—Growing bluegrass during April and May saved 20 percent of the feed for chickens, while during late June and July and early August there was no saving of feed. Bluegrass blades and seed stems contain smaller percentages of protein and higher percentages of fiber as the summer advances. Frequent clipping of bluegrass to four inches for pasture is advisable since the animal consumes more protein and less fiber and the lower height of the grass favors larger consumption by chickens. During June and July the average height of the blades was

16 inches and the average of the seed stems was 27 inches. During the month of June the ratio of dry weight of seed heads to stems was 1 : 1.6 while during the month of July, after the seed had dropped, the ratio was 1 : 3.5. Bluegrass clipped on or before April 6 prevented the formation of seed heads to a very large extent. Bluegrass cut early in April reached the same height in two weeks as did the bluegrass in the uncut plots. This is of interest because nature seems to overcome injury by increasing the later rate of growth of the bluegrass in this experiment. During late May and June, it would seem that the height of the seed spikes makes it probable that there would be very little, if any, consumption of seeds by the hens since the reaching height of the average adult chicken is approximately 25 inches.

Meat scrap versus a mixture of meat scrap and dried distillers solubles for pullet growth.—At the Western Kentucky Substation, the experiment on simplified growing rations for pullets was continued. Four broods of chicks, two each of Barred Rocks and New Hampshires, 300 chicks per brood, were started on a complete ration. When the chicks were old enough to be allowed on pasture (approximately 6 weeks) two broods were fed grain, and meat scrap (2 percent salt added), in hoppers; and two broods were fed grain, equal parts of meat scrap and distillers corn dried solubles (2 percent salt added), and steamed bonemeal, in hoppers. When the pullets were 5 months of age, 100 were selected from each group, placed in the laying house, and fed a laying mash, grain, and ground limestone. In egg production there was no significant difference between the groups.

Fiber in chick-starting rations.—The growth promoting properties of all-mash starting rations containing 0, 15, 30, 45 and 60 percent oats, and 14 and 26 percent alfalfa meal have been tested. The rations containing oats were tested in duplicate experiments and those containing alfalfa meal in only one experiment. The basal ration contained 3.6 percent fiber and the oats and alfalfa meal rations contained up to 9.8 percent fiber. The data suggested that in starting rations the source of fiber is equally as important as the amount of fiber. When ground oats was the variable source of fiber, 6.0 percent or more fiber significantly depressed growth in one experiment while in another there was no detrimental effect on growth until the fiber content of the ration reached a level of 9.8 percent. When alfalfa meal was the variable source of fiber, the growth rate was more severely depressed. Chickens fed a ration containing 9.4 percent fiber from oats (60 percent of the ration) were significantly heavier than those fed a ration containing 6.5 percent fiber from alfalfa meal (14 percent of the ration).

Abnormal anatomical structures of bones of chickens.—Results have shown that the sternum is the slowest of the eleven largest bones of the

chicken to calcify and the keel is slower to calcify than the rest of the sternum. The rate of calcification of the keel differs in individual chickens. The keels which are slower to calcify are more apt to become crooked during development. It is probable that the keel is slower to calcify than the leg bones because of the earlier duty imposed on the leg bones.

Several instances have been found in New Hampshire chickens where an anomalous unilateral condition consisted of a bony arch or connection near the proximal ends of the lateral internal and lateral external process of the sternum. At some early stage in the development of the domestic fowl such linkage of these two lateral processes may have been normal and possibly served the purpose of adding strength to the bones.

Two instances of double split keels have been noted in the Experiment Station flock. Abnormally developed metasternum or dordal medial projection of the sternum was found. This part of the sternum which is normally straight and sword like in structure and is cartilagenous at the age of ten weeks was found to be pliable, unusually broad and divided into two ends instead of one.

Growth and calcification of the humeri of male and female New Hampshire chickens having crooked keels.—At 2-week intervals from the 6th to the 28th week of growth, the humeri were dissected out from five male and five female New Hampshire chickens having crooked keels. Data concerning these bones were compared with similar data from chickens having straight keels. No significant differences were found in rate of growth of the humeri of males and of females, as shown by the average weights, volumes, and lengths, until after the 14th week, when those of the males became heavier, larger, and longer. The average biweekly growth in length of humerus was nearly the same in the male and female chickens, however, the humerus of the male was consistently longer for 28 weeks. For each sex the growth was practically the same as in those having straight keels.

The average percentages of ash in the fat-free dry humeri were nearly the same in the males and females, straight keels and crooked keels, at the 14th week, after which time until the 24th week the percentage was higher in females having straight keels than in those having crooked keels. The growth of the humerus is an orderly enlargement and the increase in size of the bone is accompanied by increase in size of air space within. The air space is caused by the solution or change of bone by the action of osteoclasts from within and the deposition of bone of like character on the outside under the periosteum by the action of osteoblasts.

Growth and calcification of the sternums of male and female chickens having crooked keels.—At 2-week intervals from the 6th to 28th week of growth, five male and five female New Hampshire chickens having crooked keels, and raised under normal conditions, were killed and

dissected. It was impossible to detect crooked keels by physical examination before the chickens were 6 weeks old, but 12 percent (7 percent males and 5 percent females) had crooked keels when examined at the 8th week. By the 28th week, 31 percent (59 percent male and 41 percent female) had crooked keels. The data were compared with similar data previously obtained on chickens having straight keels. Calcification of the rostrum was more rapid than that of the keel, proceeding at about the same rate as in chickens having straight keels, becoming ossified and rigid by the 22nd week. Complete ossification of the keels occurred in few instances by the 28th week. The average weight and volume of the crooked-keel sternums increased more rapidly in the males than in the females, but less rapidly in both sexes, in most instances, than in those that had straight keels. The marrow in the central part of the keel's plate started to disappear between the 8th and 12th week to form air spaces and the size of the area increased at about the same rates in those with crooked keels as in chickens with straight keels.

The average percentages of calcium in the dry fat-free crooked keel sternums were nearly parallel in male and female chickens during 28 weeks. The rate of calcification in the crooked keels, as shown by the progressive bone development in the keels, was about the same in males and females to the 24th week. After that the development of bone in the female crooked keels was more rapid. In the chickens having crooked keels there were many cases of perosis and other leg abnormalities. The simultaneous occurrence of crooked keel and leg abnormality probably indicates that these are related and that they result from faulty mineral metabolism.

DDT poisoning of chickens.—One occurrence of poisoning in young fowl 8 weeks of age was observed following heavy spraying of a brooder house with wettable DDT. Losses began 7 days following application of the spray. Symptoms consisted primarily of cyanosis, paresis, and convulsive movements. It appears that similar occurrences could be prevented by reasonable application of the spray on walls and avoiding contamination of the litter.

Thyroactive iodocasein in the diet and growth of chicks exposed to coccidia.—The amount of growth made in a 23-day test period by New Hampshire broilers fed a standard growing mash containing 0.04 percent added thyroactive iodocasein was compared with the growth made in the same test interval by a control group of broilers, fed the basal ration only, after both groups of birds were exposed to cecal coccidiosis.

The mean weight gain of birds fed thyroactive iodocasein was 12.7 grams greater than their controls but the difference was not significant statistically. Birds fed thyroactive iodocasein were found to be passing an average of 575,255 oocysts 23 days after infection compared with

an average of 49,485 passed by control birds at the conclusion of the test. This latter difference was statistically significant.

Helminths in chickens from Kentucky.—A survey of the nature and numbers of worm parasites in chickens in Kentucky demonstrated the presence of the following species: Roundworms, *Ascaridia galli, Capillaria annulata, C. caudinflata, C. retusa, Heterakis gallinae, Tetrameres americana;* Tapeworms, *Amoebotaenia sphenoides, Hymenolepis carioca, Raillietina cesticillus, R. tetragona.*

Thyroactive iodocasein and thiouracil in the diet and growth of chicks exposed to parasitic worms.—A comparison was made of the rate of growth of New Hampshire chicks infected with 2 species of worm parasites and fed regular starting and growing mash, with the rate of growth of other chicks, also infected with the same worm parasites, fed the same starting and growing mashes to which 0.04 percent thyroactive iodocasein, or 0.1 percent thiouracil, had been added.

In 3 of 4 experiments most rapid growth was made by chicks receiving thyroactive iodocasein. The slowest growth rates were made by chicks receiving thiouracil. Chicks on the normal diet grew at rates superior to birds fed thiouracil and inferior to chicks fed thyroactive iodocasein. The mild hyperthyroid condition induced by feeding thyroactive iodocasein evidently aided chicks to overcome the effects of worm infection and recover more rapidly from weight losses due to infection. These experiments, however, gave no evidence that addition of thyroactive iodocasein to the diet of parasitized chickens would enable them to maintain rates of growth equal to those of uninfected chickens.

Aggregate worm infections and growth of broilers.—Weights gained in 3-week test periods by balanced groups of New Hampshire broilers following direct exposure to infective eggs of *Ascaridia galli* (Schrank, 1788), or to infective eggs of *Heterakis gallinae* (Gmelin, 1790), or to infective eggs of both species, were determined. Progressive retardation of growth occurred as the number of species of worms constituting the infections increased. Effects of parasites upon their hosts were evidently dependent upon the aggregate number of species present. The period of migration of immature stages of the two worms into, or from, the mucosa of the digestive tract was linked to periods of weight losses.

Retardation of growth resulting from the presence of the individual species in the host indicated that *H. gallinae* is of as great economic importance as *A. galli,* at least in birds classified as broilers.

Diagnosis of Newcastle disease.—Material was obtained from 37 flocks to be examined for Newcastle disease. The presence of the disease was established by the serum neutralization test in 16 flocks, and by virus isolation in 4 flocks. The disease has been more prevalent in young chicks than in laying stock, and more frequently in the spring when there is con-

siderable movement of chicks. Started chicks appear to be the principal means of spreading the disease to new localities.

Newcastle disease vaccines.—In pathogenicity testing of a number of Newcastle viruses one strain gave promise of use as a live virus vaccine. It was of sufficiently low pathogenicity for vaccinal use on birds 6 to 8 weeks of age, in which intramuscular aministration of 100,000 embryo lethal doses caused no clinical symptoms. In chicks 3 weeks of age or younger, the virus caused visible systemic disturbance and respiratory symptoms, with nervous symptoms occurring in approximately 5 percent of vaccinated birds.

Intramuscular doses of 1 cc of formalized amnio-Allantoic fluid have protected young chicks for periods of 2 to 2½ months against continuous contact exposure.

Transmission of virus of Newcastle disease through eggs.—Twelve dozen eggs were collected 30 days following an outbreak of Newcastle disease in a laying flock and incubated in a test of transmission of virus of Newcastle disease. No virus was recovered from infertile eggs at 7 days of incubation, from embryos dead at 7, 12, and 15 days of incubation, or from embryos failing to hatch at 21 days of incubation. Sixty chicks hatched from the eggs showed no evidence of Newcastle disease during 3 weeks of observation.

Immediately before being placed in the incubator, a group of 10½ dozen eggs from non-immune hens were injected with 100,000 embryo lethal doses of virus into the yolk sac. Forty chicks were hatched from the eggs and observed for 3 weeks. Neither clinical nor serological evidence of Newcastle virus infection was found.

Avian encephalomyelitis (epidemic tremor).—Twenty-three outbreaks of this virus infection in young chickens were identified during the year, whereas there were only 3 in 1947. Ages of affected chicks ranged from 1 to 4 weeks, and mortality losses ranged from 1 to 44 percent in different flocks, the average being about 10 percent. Experimental injection of virus into unincubated eggs resulted in development of the disease in chicks hatched from the eggs. After storage for 6 months at zero Fahrenheit, brain virus was found to be non-infective for chicks 3 days of age. Incubation periods in chicks injected intracerebrally with brain suspension ranged from 12 to 48 days.

Control of chicken lice.—Laboratory tests were made to compare the efficiency of benzene hexachloride, chlordan, and 40-percent nicotine sulfate for control of chicken lice. Excellent control of body, shaft, and fluff lice was obtained with one application of 5-percent chlordan powder on the bird, 2 drops of 40-percent nicotine sulfate applied to the bird, and 40-percent nicotine sulfate applied to roosts at the rate of 0.4 cc per foot

of roost. One application of an oil solution of benzene hexachloride containing 1.25 percent of the gamma isomer, used either as a roost paint or applied directly to the bird, gave fairly good immediate control of lice but did not have enough lasting quality to kill all of the lice hatching from eggs.

Mares as sources of worm infections for foals.—At six Thoroughbred nurseries in central Kentucky the systems of worm-parasite control in use were studied by means of weekly fecal examinations of individual mares and their foals. On five of the farms an immediate and cyclic rise in worm burden, as reflected by increasing numbers of worm eggs passed, was found in mares after foaling. This rise coincided with the coming of warmer weather and better pastures. On the five farms, peaks in cycles of infection occurred in mares without relation to therapeutic treatment, and intervals between peak infections became progressively shorter in late spring and early summer. Strongylid infection in foals closely paralleled that in mares at a given farm, but ascaris infection in foals was not linked to infections in mares. Where mares were given therapeutic treatment for strongyles in the fall, both the mares and their foals had, in general, lower worm burdens in the spring than when mares were not given such therapeutic treatment.

Only one farm was successful in keeping strongylid infections in foals consistently low. This farm used an intermittent system of feeding low-level amounts of phenothiazine to the mares, before and after foaling, and continuing until weaning, when the weanlings were placed on the low-level phenothiazine intake and the mares turned out. The mares at this farm did not follow the pattern of cyclic increases in worm burden characteristic of mares at the other farms.

Diethylcarbamazine (Caricide) for bloodworms in horses.—Preliminary dosage trials were made on three adult horses to establish toxicity and possible *in situ* efficacy of diethylcarbamazine against larvae of *Strongylus vulgaris*. One horse weighing 1,100 pounds was given 25 grams of diethylcarbamazine with a stomach tube for 6 consecutive days. No effect was noted upon bloodworms *in situ*. Another horse weighing 1,000 pounds was injected intravenously with 8 grams of diethylcarbamazine in 30 cc of sterile normal saline; five injections of 4 grams in 20 cc of sterile normal saline were given once a day for the following 5 days. No effect was noted upon bloodworms *in situ*. A third horse, weighing 1,000 pounds, was given 3 daily intravenous injections of 4 grams of diethylcarbamazine in 20 cc of sterile normal saline for 6 consecutive days. No effect was noted upon bloodworms *in situ*.

When diethylcarbamazine was administered by stomach tube no reaction resulted in the horse and no lesions were found upon post-mortem examination. Intravenous administration of 8 grams resulted in an immediate temporary nervous reaction, temporary loss of muscular coordination, and

temporary respiratory distress. Reaction to intravenous injection of 4 grams resulted in the same symptoms, but not as severe. In each case indications of distress disappeared within 10 minutes of treatment.

No action of diethylcarbamazine against strongylids in the digestive tract was found. No evidence of change in the blood picture of the 3 horses could be found when blood samples were taken.

Sodium fluoride for ascariasis in horses.—A series of dilution egg-count tests, and a total of 30 critical tests, were conducted with sucklings, weanlings, yearlings, and mature horses to evaluate the efficacy of sodium fluoride as an anthelmintic for ascariasis. In all tests a suspension of sodium fluoride in water was given with a stomach tube to horses on full feed.

When administered at a rate of 2.5 grams per 100 pounds of body weight, sodium fluoride was 99.8 percent efficient in expelling ascarids from the small intestine. Of 1,156 worms present in 10 horses 1,154 were expelled from the small intestine; 1,034 (89.4 percent) were dead within 24 hours after treatment.

When administered at a rate of 1.5 grams per 100 pounds of body weight, the efficiency of expulsion of ascarids from the small intestine was decreased and efficiency as an ascaricide was decreased.

After euthanasia, in horses receiving 2.5 grams per 100 pounds of body weight, catarrhal and hemorrhagic gastritis and enteritis were found frequently. These conditions did not occur as often at the rate of 1.5 grams. A watery diarrhea generally developed 24 hours after treatment, at either rate.

Two mares, weighing 1,062 and 1,056 pounds were each given 31.5 grams of sodium fluoride. Twenty-four hours later both animals showed depression, inappetence, and severe diarrhea. No change could be detected in pulse, respiration, or temperature. Forty-eight hours after administration they resumed feeding, although both animals still exhibited depression and diarrhea. Seventy-two hours after administration the animals were normal in action and appearance.

Blood samples were taken of 1 suckling, 5 horses, and 2 mule weanlings following administration of sodium fluoride. There was no change in the blood picture, except that when diarrhea occurred there was an increase in the red-blood-cell count and hemoglobin, due to dehydration.

Continuous administration of phenothiazine to horses.—Twelve horses (11 mares and 1 stallion) were given low-level amounts of phenothiazine daily, beginning April 27. The 12 horses were divided into four groups, the first group receiving 0.5 gram daily, the second 1.0 gram daily, the third 2.0 gram daily, and the fourth 4.0 gram daily. When the experiment was begun the phenothiazine was placed on top of the grain ration consisting of ground corn-and-cob meal. On July 1 the grain ration was changed to whole oats.

Strongyle egg counts and fertility of strongylid eggs passed by the horses were reduced, the amount of reduction being directly related to the increasing amounts of phenothiazine received. After 8 months of the test the horses gave no evidence of being affected adversely.

Effect of phenothiazine treatment of horses on fertility of strongylid eggs.— Strongylid egg counts were obtained at weekly intervals for 10 mares and their foals at one Thoroughbred nursery where a system of intermittent low-level phenothiazine administration was used, and also for approximately 30 mares and their foals at five other nurseries where this system was not used. In a 7-week period, a total of 503 strongylid eggs were observed in fecal samples from the one stud. Of this number, 348 (69.2 percent) were infertile. The percentage of infertile eggs in the weekly samples ranged from 51.8 to 78.5. In the same period, a total of 5,820 strongylid eggs were observed in the counts from the other horses and of this number 228 (3.9 percent) were infertile. The percentage of infertile eggs from these latter horses ranged from 2.1 to 6.4.

The system of intermittent low-level phenothiazine administration employed at the one stud evidently was responsible for the comparative infertility of strongyle eggs passed by the horses.

Caronamide inhibition of renal tubular excretion of penicillin.— Caronamide, a drug which inhibits tubular excretion of penicillin by enzyme competition, was studied as a possible adjuvant to penicillin therapy in horses. When administered in optimum dosage of 4 to 6 grams/cwt immediately before intramuscular injection of 500 units/lb of penicillin in aqueous solution, the drug was quite effective in inhibiting excretion of penicillin. The serum levels of penicillin were enhanced threefold to sixfold for the first hour and for the second hour following injection, sixfold to 16-fold for the third hour, and fourfold to 25-fold for the fourth hour. Penicillin serum levels of 1.28 to 5.12 units/ml were obtained for the first hour following injection with a gradual falling throughout the measurable serum-level period. Practical applications of the drug have not been determined.

Serum levels with penicillin in oil and wax and procaine penicillin in oil.—Efficiency of penicillin in oil and wax (Romansky formula) was compared with the efficiency of procaine penicillin in oil. The Romansky formula was represented by the calcium, sodium, and potassium salts of crystalline penicillin G suspended in peanut oil containing 4.8 percent white wax U.S.P., and containing 300,000 units per ml. The other product was procaine penicillin G suspended in sesame oil containing 300,000 units per ml. With the Romansky formula, doses of 1,000 units lb intramuscularly produced therapeutically significant serum levels that ranged in duration from 3 to 12 hours and averaged 7 hours. For the same dose of procaine penicillin the range was 9 to 21 hours and the

average 14 hours. Romansky formula in doses of 2,000 units lb produced serum levels ranging in duration from 6 to 24 hours and averaging 7 hours, while with the same dose of procaine penicillin the range was 18 to 24 hours and the average 20 hours. For 4,000 units lb doses the serum levels from the Romansky formula ranged in duration from 6 to 14 hours and averaged 10 hours, whereas those from the procaine penicillin exceeded 24 hours in all trials.

Serum levels of penicillin following intramuscular injection of aqueous solutions.—With doses of 500 units/lb of body weight, a measurable serum level of penicillin may be expected for 3 hours in young foals and sheep. In yearlings and adult horses, the same dosage will maintain a slightly higher level for 4 to 5 hours. With doses of 1,000 units/lb the serum concentrations were essentially double those obtained with 500 units/lb but the measurable serum level period was not significantly prolonged. Doses of 2,000 units/lb usually doubled the serum levels obtained with 1,000 units/lb, quadrupled those obtained with 500 units/lb, and extended the measurable serum level period 1 to 2 hours longer than that obtained with 500 units/lb.

Serum levels of streptomycin in horses.—With doses of 0.5 mg/lb of body weight, intramuscular injection of streptomycin at 3-hour intervals usually maintains a serum level of 1.0 to 2.0 units/ml of serum in young foals and small yearlings, with a slightly higher trend in yearlings. Serum levels between 2.0 and 4.0 units/ml of serum were obtained with this dose in adult horses. In foals doses of 1.0 mg/lb maintained serum levels of 2.0 to 4.0 units/ml of serum, while in adults and yearlings this dose produced serum levels of 4.0 to 8.0 units/ml. Doses of 2.0 mg/lb resulted in serum levels ranging from 4.0 to 16.0 units/ml of serum in foals, 8.0 units/ml being the most frequently occurring value. With the same dose in yearlings the serum level ranged from 8 to 16 units/ml and in adults from 16 to 32 units/ml. In foals doses of 4.0 mg/lb resulted in serum levels ranging from 8 to 32 units/ml, and 16 units/ml was the most frequently occurring value.

Streptomycin for treatment of Shigella equuli infections of foals.—Use of streptomycin alone or simultaneously with penicillin resulted in recovery of 13 of 17 sick foals. Five cases regarded as typical of *Sh. equuli* infection recovered when treated with streptomycin. Three foals with typical symptoms recovered promptly when treated simultaneously with streptomycin and penicillin. Another foal which failed to respond to penicillin therapy recovered slowly when streptomycin was given. The others, apparently having concurrent infections of *Sh. equuli* and streptococci, recovered slowly during intensive treatment with both streptomycin and penicillin. The dose of streptomycin was uniformly 0.5 gm intramuscularly at 3-hour intervals. Penicillin dosage ranged from 300,000

to 600,000 units of Romansky formula intramuscularly at 12-hour intervals. To be successful, it appears that treatment with streptomycin should be started early in the course of the disease and continued for 24 to 48 hours after the temperature returns to normal. Past studies have shown that *Sh. equuli* kills more foals each year than any other microorganism, usually accounting for 40 percent of the deaths in foals. Last year it accounted for 13 percent of the deaths in foals examined at this laboratory.

Blood picture of the thoroughbred weanling.—Red-blood-cell counts and differential counts were made on 36 weanlings from three horse farms. White-blood-cell counts, hemoglobin concentration, and packed cell volume were determined on 82 weanlings from six farms. The following means and their standard deviations were obtained: red blood cells mm^3, 11,500,000±900,000; white blood cells/mm^3, 13,600± 2,400; MCHC (mean corpuscular hemoglobin concentration) 34.4±2.4 percent. The following means were obtained: hemoglobin, 12.4 gms/100 ml; packed cell volume, 36 percent; mean cell volume, 31.9 cubic micra. The mean differential counts in percent were: neutrophils, 51.8; lymphocytes, 40.7; monocytes, 4.6; eosinophils, 2.9; and basophils less than 0.5.

Preliminary data on the blood picture of thoroughbred foals (sucklings) indicate a hemoglobin level of 11.5 gms/100 ml of blood in contrast to the generally accepted standard of 14 gms/100 ml.

Blood picture of horses on low level or on therapeutic doses of phenothiazine.—Counts of red and white blood cells, packed cell volume, hemoglobin, and differential counts were made on 10 weanlings and 10 foals on a farm using low-level phenothiazine for worm control. The low-level phenothiazine treatment consisted of giving 2.5 gm daily for 2 weeks followed by 1 week of no treatment.

Other workers have demonstrated that phenothiazine in therapeutic doses produces a temporary anemia of the hemolytic type. This same type of anemia was noted in weanlings and foals on low-level phenothiazine but was not as pronounced as when the therapeutic dose was employed. During the 6 weeks in which weekly blood samples were taken only 2 of the 10 weanlings dropped below the standard deviation of the normal MCHC (mean corpuscular hemoglobin concentration) of 34.4± 2.4 percent; both of these weanlings showed a MCHC of 31.4 percent. No significant changes in the white cell counts or differential counts were seen.

Effects of therapeutic doses of phenothiazine on the blood picture of 9 Thoroughbred foals were studied. Two days after administration of a therapeutic dose (12.5 gms) the mean MCHC dropped 2.9 percent and then increased more or less steadily for 18 days. Seven days after this dosage the foals were put on a high-protein diet, and 21 days after the first dose a second therapeutic dose was administered. This second dose

reduced the MCHC 2.8 percent (from its pretreatment level) 4 days after treatment. The difference in rate and degree of drop in the MCHC resulting from the two therapeutic doses was ascribed to the high protein diet given these foals for 14 days before the second therapeutic dose.

Blood picture of horses on various levels of phenothiazine.—Twelve horses, 6 of which were Thoroughbreds, were given daily doses of phenothiazine mixed with their feed for a period of 8 months. Of these, 2 Thoroughbreds and 1 grade animal received 0.5 gm daily, 3 Thoroughbreds 1.0 gm daily, 1 Thoroughbred and 2 grade animals 2.0 gm daily, and 3 grade animals 4.0 gm daily. Blood samples were taken every 4 weeks; red- and white-blood-cell counts and differential counts were made.

At the end of 8 months two of the horses receiving 0.5 gm daily had gained in MCHC (mean corpuscular hemoglobin concentration) and one had dropped 0.2 percent. Of those receiving 1.0 gm daily, two showed no change in MCHC and one a drop of 1 percent. Of those receiving 2.0 gm daily, all three dropped in MCHC, ranging from 0.9 to 1.8 percent; while of those receiving 4.0 gm daily, one horse gained in MCHC and two dropped 0.4 and 2.6 percent. This drop of 2.6 percent was the only instance in which a lowering of the MCHC put the individual below the normal MCHC established for the breed.

Results of post-mortem examinations of equine fetuses.—During the year 91 fetuses were presented for post-mortem examination, the highest number so far examined in one year. Equine virus caused 25 of the abortions, streptococci 6, *Escherichia coli* 1, and *Shigella equuli* 1. There were 18 cases of twin abortions and 40 abortions in which the cause was not determined.

Over a period of 26 years abortions due to streptococci accounted for 17 percent of the total. Within the past few years the incidence of streptococcic abortions has been dropping. In 1948 it caused less than 7 percent of the abortions recorded.

A motile streptococcus from an equine fetus.—Most of the streptococci abortions are caused by cocci that are beta-hemolytic, ferment lactose and sorbitol, and belong to the Lancefield group C. Recently a motile streptococcus of group D was isolated from the umbilical vein, spleen, liver, heart, lungs, and stomach fluid of an equine fetus aborted during its sixth month of gestation. This is the first instance of a microorganism of that type being recognized in an equine abortion.

Equine virus abortion.—In 1948 equine virus abortion constituted 28 percent of the total abortions. Besides causing 25 abortions this virus appeared in 5 foals, most of which died shortly after birth. One of these foals lived until it was 31 days old. On post-mortem examination it showed typical lesions of equine virus abortion.

Hand-bred guinea pigs were used in attempts to propagate the virus of equine abortion. Sixteen pregnant guinea pigs were injected intraperitoneally with suspensions of liver tissue from virus cases. Only one aborted, and the injection of tissue suspensions from the aborted fetuses into other pregnant guinea pigs did not cause further abortions. Laparotomies were performed on 17 pregnant guinea pigs after the 28th day of gestation. After exposing their pregnant uteri, injections consisting of liver tissue suspensions from equine virus cases were made into the cotyledons and fetuses. Of these 17 guinea pigs, 7 did not survive the operation, 9 gave birth to normal offspring and 1 gave birth to a dead offspring. In most cases the number of young born was less than the number of fetuses injected.

Attempts were made to propagate the virus in day-old hamsters. However, sufficient hamsters have not been used to date to draw definite conclusions on the outcome of this experiment. It was not possible to establish the virus by injecting it into the testicles of hamsters.

Three pregnant mares were injected intravenously with a liver-and-lung-tissue suspension of a virus fetus. These tissues had been frozen at 10 degrees below zero for 2 months. One of the mares aborted a virus fetus on the 18th day following the injection. The other two mares gave birth to normal mules. Apparently the virus can be held for several months at freezing temperatures.

Genital infections in mares.—In 1948 255 cultures inoculated with material taken from the genital tracts of mares were examined. Of these cultures 132 proved to be negative, 81 contained streptococci, 21 contained *Escherichia coli*, 13 contained staphylococci, 6 contained *Pseudomonas aeruginosa*, and 2 contained *Corynebacterium equi*. This work was done in controlling genital diseases of mares and thereby preventing certain types of abortion.

Salmonella abortus-equi vaccine.—No cases of *Salmonella abortus equi* abortion were found. *S. abortus-equi* vaccine for the treatment of 1,398 mares was prepared and dispensed. Blood samples from 104 mares were tested for *Salmonella abortus-equi* infection. Three were found to be positive.

Equine virus abortion vaccine.—A total of 1,763 pregnant mares were vaccinated during the year with equine virus abortion vaccine. Of these mares 1,430 were in Kentucky. No cases of virus abortion appeared in a total of 851 pregnant mares which had been vaccinated in the fall of 1947. On 15 farms, 28 non-vaccinated mares produced virus cases and on these farms a total of 213 pregnant mares were vaccinated after one or more virus abortions had occurred. Of these 213 mares, 2 aborted virus fetuses in less than 30 days following vaccination and one aborted after 60 days. Still another mare produced a foal 108 days after vac-

cination, but the foal died of virus infection within 3 days after birth. Although a few of the 213 vaccinated mares aborted from other causes, they did not present any more cases of virus abortion.

Results of post-mortem examinations of foals.—Foals presented for post-mortem in 1948 totaled 87. The causes of death were listed as equine virus abortion, 5; streptococci, 19; *Escherichia coli*, 6; *Shigella equuli*, 11; *Clostridium septicum*, 1; anomalies, 4; traumatic injury, 3; dystocia, 4; hemolytic icterus, 6; tumor of the liver, 1; and torsion of the intestine, 2. In 25 foals the cause of death was not determined.

Hemolytic icterus in foals.—Hemolytic icterus in newborn foals was shown to occur when mares sensitized to certain types of erythrocytes were bred to stallions which transmitted that type of blood cells to their offspring. The condition was observed in apparently normal newborn foals after they had obtained from the dams' milk the antibodies which destroyed their erythrocytes. A sensitized mare which was bred to a stallion whose cells were compatible with the mare's cells did not produce an icteric foal. Susceptible foals sired by stallions whose cells were not compatible with those of the mare did not develop icterus if placed on nurse mares immediately after birth. Upon the appearance of hemolytic icterus, the foal was removed from its dam and 1,500 cc of its antibody-laden blood was withdrawn and replaced by 2,000 cc of compatible blood.

Salmonella and paracolon bacteria.—A total of 1,251 cultures of enteric bacteria were examined in 1948. Of these cultures, 485 were isolated from man, 716 from animals, and 50 were derived from other sources. Classification of the 1,251 cultures showed 952 strains of *Salmonella*, 15 strains of Arizona paracolons, 61 strains of Bethesda paracolons, and 223 strains of other enteric bacteria.

Six new Salmonella types were identified—*S. memphis* (XVIII: k-1,5), *S. san-juan* (VI,VII:a-1,5), *S. edinburg* (VI,VII:b-1,5), *S. pharr* (XI:b-e,n,z_{15}), *S. lomita* (VI,VII:e,h-1,5), and *S. rio-grande* (XL:b-1,5). In addition the identities of 6 new *Salmonella* types were confirmed for other laboratories.

In continued studies on induced variation it was found that O antigens as well as H antigens were susceptible to change by growth in agglutinating serums. Antigen III,X was changed to III,XV and vice versa. Thus the identities of such strains as *S. anatum* and *S. newington* or *S. meleagridis* and *S. cambridge* were reversible. The antigenic pattern of the *Salmonella* group indicates that many such changes occur in nature.

A new group of paracolon bacteria, designated as the Bethesda group, was studied by antigenic analysis. A number of antigenic groups and types were established and the types were found to be epidemiologically significant. Hitherto unrecognized forms of antigenic variation which have a distinct bearing on classification were noted. This group of para-

colon bacteria occurs commonly in man and domestic animals. It is a very complex group of bacteria whose final classification will require much more work. The types thus far established comprise only a few of many that are known to exist. The pathogenic significance of the bacteria cannot be established until the group is better understood.

Polyvalent serums for rapid identification of *Salmonella* cultures were investigated. These serums, which contained agglutinins for all the antigens of the genus, were prepared in two ways. First, all the antigens were injected into a single animal. Second, the antigens were made up in three pools and each pool, consisting of 10 to 12 antigens, injected into individual rabbits and the serums combined. Both methods were satisfactory but the latter is more convenient for large-scale production. These serums were made in large amounts and distributed to other laboratories.

S. pullorum variant strains.—The nature of the variant or X strains of *S. pullorum* described by Canadian workers was studied. It was found that the variation was due to form variation involving antigens XII_2 and XII_3 of *S. pullorum*. Variant strains contained large amounts of XII_2, standard strains had large amounts of XII_3. This variation had a marked effect upon the antigenic properties of the cultures and upon the agglutination test for the detection of pullorum disease in hens. In Kentucky, one-third of the chicks affected with *S. pullorum* yielded variant strains and these appeared much more frequently in chicks from certain hatcheries. It was further found that some hatchery supply flocks reacted in agglutination tests when variant strains were used as antigen but would not react to standard strains. From such hens variant strains of *S. pullorum* were isolated. Largely as a result of this work, it is now permissible to use antigens containing variant cultures of *S. pullorum* in testing done under the National Poultry Improvement Plan.

Seed inspection.—During the year 10,517 samples of seed were tested, of which 693 were official samples taken by inspectors from the stock of wholesale and retail merchants. The remaining samples, sent to the laboratory by seedsmen, farmers, and others, included 4,339 samples of grass seed, 2,864 of legume seed, 1,780 of cereals, 557 of tobacco seed, 173 of vegetable seed, 75 of hemp seed, 8 of cotton seed, 6 of rape seed, 2 of flower seed, 6 of miscellaneous seed, and 14 seeds for identification. Tobacco seed cleaned during the year amounted to 2,867 pounds. Fescue samples again outnumbered all other varieties of seed tested this year.

Nursery inspection.—During the year 95 regular inspections were made, including 61 inspections of general nursery stock, 14 of bulbs and perennials, 7 of fruit trees, 5 of strawberry plants, 5 of sweetpotato plant beds, and 3 of greenhouses. In these examinations the following insects and plant diseases listed in the order of frequency of occurrence were found. Insects: bagworm, white pine aphid, oriental fruit moth, thrip,

strawberry crown borer, iris borer, pine shoot moth. Diseases: apple leaf rust, cedar rust, peony blotch, cherry leafspot, pear leaf rust, iris leafspot, juniper twig blight, delphinium leafspot.

Red spider was the most prevalent and most important pest in the nurseries this year. It appeared in great numbers and caused noticeable damage in practically every planted area in the state.

Fertilizer control.—More fertilizer samples (1,587) were analyzed and reported in 1948 than in any previous year. Almost 2,500 visits were made to dealers' warehouses offering fertilizer for sale. Inspection showed over 97 percent of the fertilizer on hand was tagged with official tags at the time. Tags were received later by the dealers from the manufacturers, for shipments not tagged.

Of all the fertilizer inspected 62.2 percent met guarantee in all respects or was better than the guarantee. This was an improvement over the record for 1947, about the same as for 1946, but below the 1945 figure of 68.3 percent. The "tight" fertilizer situation with respect to ingredients, the great demand for these materials by farmers, and the fact that manufacturing facilities have been taxed to the limit has made it difficult to greatly improve this relationship. In a situation of this kind the fertilizer control program has been of immeasurable help to farmers and the manufacturers alike in helping to keep analyses up to guarantee.

Ninety percent of all analyses were within 0.25 percent of the guarantee, the tolerance allowed by law. Where a product was radically at variance from the guarantee it was either withdrawn from sale, retagged, or refund was made, depending upon the circumstances. No cases were filed for prosecution during the year.

An investigation on sampling fertilizer and other collaborative work was continued and the results reported to the Association of Official Agricultural Chemists. Check samples and samples for dealers and farmers were also made.

License tags were issued for 554,058 tons of fertilizer, the largest total for Kentucky on record and about 100,000 tons greater than the previous year.

Feed control.—Inspection samples analyzed reached an all-time high of 2,799. Special attention was given to microscopical analyses in determining whether or not the ingredients used agreed with those listed on the tag. A systematic re-check was made on samples found not as guaranteed, in an intensive effort to help manufacturers bring them in line.

Approximately 56 percent of all samples of feed equaled guarantee or were sufficiently close to guarantee to be classified as "passed." This compares with a figure of 64 percent in 1947 and is considerably better than the figure of 52 percent reported for 1946.

Seventy-eight percent of the samples analyzed were within 0.5 percent (the tolerance allowed) of the guarantee in protein, 86 percent were

within the tolerance for fat, and 87 percent for fiber. Ten percent of all samples analyzed were classified as adulterated. Adulterations included too much salt, ground limestone, or other minerals; presence of alfalfa stem meal when alfalfa meal was guaranteed; or presence of rice hulls, corn cobs, oat hulls, screenings refuse, and such.

Fourteen cases were filed in court and fines were assessed in seven. The remainder were dismissed upon agreement of the parties concerned to correct the matters involved.

Over 8,000 visits were made by inspectors to warehouses of feed dealers throughout the state during the year. Over 93 percent of the feed on hand was tagged with official Kentucky labels at the time of inspection. With less than 2,000 such dealers in the state, visits averaged slightly over four per dealer during the 12 months.

Special inspections of dog feeds and mineral feed were made. Weight checks were made when advisable. One company having a serious weight difficulty made substantial reimbursement to purchasers and corrected the situation promptly.

Collaborative work with the National Research Council, Feed Control Officials in other states, and with other departments of the Kentucky Agricultural Experiment Station was continued. A total of 336 samples of a special nature were analyzed for these cooperating groups, including those sent in by manufacturers, dealers, and consumers.

License tags were issued for 650,300 tons of feedstuffs. This was slightly larger than in 1947. The tonnage of feed sold in Kentucky each year has shown little change for the last four years.

Public Service Laboratories.—A total of 28,900 samples of foods, drugs and public health specimens were examined in this department during the year. Microscopical examinations were made on 439 animal heads, of which 208 or 47.3 percent were found to be positive for rabies, an increase in the number of positive heads of 12.2 percent over the previous year. A total of 3,978 cultural and microscopic examinations were made on 1,989 throat swabs for diptheria and scarlet fever, of which 88 specimens were found to be positive for diphtheria and 215 positive for beta hemolytic streptococci, certain strains of which cause scarlet fever.

Microscopical examination of stained smears prepared for specimens of sputum, concentrated by the flocculation method, were made on 1,104 specimens. Acid fast bacilli, morphologically identical with Mycobacterium tuberculosis, were found in 150 or 13.5 percent of the specimens examined. Of 511 microscopically negative specimens cultured on special media, 24 were found to be positive for tubercle bacilli by culture.

A total of 1,295 specimens of feces were examined for intestinal parasites and ova. Of these, 263 were positive for Ascaris lumbricoides; 52 for hook-worm (Necator americanus); 108 contained Trichuris trichiura; and 9 specimens were positive for Taenia nana.

Of 8,054 specimens examined for the presence of gonococci, 2,270 or 28.1 percent were reported positive or suspicious, as compared with 32.5 percent positive in 1947. Of 196 ophthalmic smears from eyes of new born babies examined for gonorrheal ophthalmia, 84 were reported positive and 112 negative.

Bacteriological examinations were made on 1,196 specimens of feces and urine, chiefly from food handlers, for examination for typhoid, paratyphoid, dysentery, and Salmonella organisms. E. typhosa was isolated from 5 feces, of which 1 was from a food handler, 1 convalescent case, and 3 unclassified. Organisms of the Salmonella group were found in 2 feces, one from a food handler and the other from an incipient case for diagnosis.

Bacteriological examination was made on 4,331 samples of water for sanitary quality to ascertain if safe for drinking. The samples were from wells, springs, cisterns, pools, reservoir, and city or municipal water supply.

A total of 3,442 milk-product samples were received during the year, submitted chiefly by milk inspectors from county health departments. Samples consisted of 3,317 milk, 26 cream, 36 ice cream, 24 buttermilk, 33 chocolate milk, and 6 of cottage cheese. The examinations show that sanitary conditions in dairy and milk plants need improving, as a large number of the samples, both of raw and of pasteurized milk, were of very poor sanitary quality. Milk is a perishable food product, subject to contamination from the moment it is produced until it is consumed, and it requires constant and competent attention to sanitary conditions to produce a pure and wholesome product, such as every consumer has a right to expect.

Special examinations were made of some 63 samples of food material submitted in connection with 19 cases of suspected food poisoning, varying from one or two persons to as many as 150 made ill from eating contaminated food. Milk, baked ham, creamed chicken, custard, sandwich filling, and miscellaneous food products were found to be contaminated with hemolytic staphylococci as the chief offender, and almost invariably associated with E. coli and other intestinal type organisms, indicating poor sanitary conditions existed during the production, storing, and handling of the prepared food.

Twenty-two samples of disinfectant products were submitted by the Division of Foods, Drugs, and Hotels of the State Department of Health, for assay as to their germicidal potency when used as disinfectants in and about restaurants, dairies, and similar food-handling establishments. Sixteen were found to be germicidal to the test organism in 2 minutes or less; 4 were germicidal in 5 minutes or less and 2 were not germicidal in 15 minutes under condition of the test and in dilutions recommended.

Chemical examinations were made of 3,223 samples of dairy products; of which 3,051 were samples of milk, 32 chocolate milk, 36 cream, 49 ice cream, 24 buttermilk, and 31 miscellaneous dairy products. One

hundred samples of milk were found to be adulterated with added water, with a maximum of 45 percent found in one case; 70 were below legal standard of 3.25 percent butterfat; 26 samples of milk, 4 of cream, and 2 of buttermilk were underpasteurized, 5 cream and 8 ice cream samples were below standard for butterfat. Of 46 samples of granular curd cheese submitted for the phosphatase test for efficiency of pasteurization, 6 were found to be underpasteurized. Of 26 samples of hamburger or ground beef, 9 were found to be adulterated with sulphites, cereal, or added water.

Chemical examinations were made of 17 samples of drug products submitted by the Division of Foods, Drugs, and Hotels of the State Department of Health, of which 8 were disinfectant products for strength and composition, 2 cosmetic preparations, and 7 proprietary drug products.

A total of 131 samples of water were examined, 89 for chemical composition for presence of harmful or toxic substances, 11 for sewage or other underground contamination, 21 for data for treatment or for construction of sewage disposal plants, and 11 samples for complete chemical analysis, submitted in connection with the United States Geological Survey in Kentucky.

Thirty-three examinations were made for poison or other harmful material in foods, drugs, beverages, and medicinal products, including material from suspected food poisoning.

Toxicological examinations were made of the stomach and other organs taken at autopsy on 6 humans and submitted by county coroners for examination for poison and to establish cause of death. Examination of the stomach contents and feed material were analyzed for poison in connection with the death of 27 animals suspected of having died from poison.

Creamery license section.—Licenses to buy milk or cream on butterfat basis issued and now in force total 997, of which 973 are renewals and 24 are for buying places beginning operation after July 1. The total includes 6 creameries, 14 cheese plants, 8 condenseries, 82 milk plants and ice cream manufacturers and 887 cream buying stations. Authority to test for the period ending June 30, 1949, was issued to 1,158 operators of the Babcock test, including 924 renewal licenses, 98 licenses issued since July 1 following satisfactory examination, and 136 permits pending examination issued since July 1.

Examinations for applicants for license to test were held as follows: Bowling Green 3, Columbia 2, Lexington 2, Louisville 2, Mayfield 2, Maysville 1, Owensboro 1, Princeton 1, Somerset 2, Walton 1, special 25. Of 327 applicants notified to appear for examination 213 appeared, 200 passed, and 13 failed.

Of 19,919 milk and cream test bottles, cream test weights, and milk pipettes received for calibration, 28 were rejected. Items of operating equipment in use found on inspection to be incorrect or defective and

possible cause of inaccurate weights or tests were: 3 test scales, 61 cream test weights, 9 receiving scales, 9 centrifuges, 1 pair dividers, 12 thermometers, 25 pieces illegal glassware. These were condemned and ordered to be replaced.

During the year 880 inspections of buying places were made, including 23-215 Babcock tests of milk and cream. On basis of these inspections operators were graded as follows: A and B (satisfactory) 479, C (unsatisfactory) 326, D (probation) 63, and E (cited to appear before Examining Board) 12.

The Examining Board disposed of 12 cases of operators cited to appear before it because of unsatisfactory inspections and violation of regulations as follows: 7 licenses and 2 permits revoked, 2 operators placed on probation with a decision to be based on future inspections, and 1 previously revoked license reinstated.

Receipts for the year from station licenses were $6,119.00; from tester's licenses, $2,507.56; and from glassware, $562.33: total, $9,188.89.

WESTERN KENTUCKY SUBSTATION

General farm production.—Crop production was unusually good this year, largely because of ample rainfall during the summer months. Corn, wheat, tobacco, and hay yields were high. Pastures were exceptionally good throughout most of the season. In late summer a new seeding of alfalfa and bluegrass was made on a 15-acre field; an excellent stand was obtained. Approximately 1,400 bushels of peaches and 800 bushels of apples were harvested and sold off the farm in 1948.

An excellent crop of corn was produced on some of the thinnest and most sloping sandstone land of the farm, which was cultivated to destroy wild vegetation and in order to retreat with lime and phosphate and to reseed to permanent pasture mixture. It had been formerly treated with lime and phosphate and had been in pasture and meadow for a number of years. Twelve acres of this corn filled two 75-ton silos. Corn on the remaining 10 acres, the thinnest and steepest part of this field, averaged approximately 60 bushels per acre.

Dairy herd.—Milk and butterfat production per cow were somewhat higher than for several years, and more cows were in the herd. Dairying, therefore, produced a greater total income than usual, but feed costs were unusually high until the latter part of the year. According to Dairy Herd Improvement Association records from December 1, 1947 to December 1, 1948, production averaged 7,519 pounds milk and 417 pounds butterfat per cow, with an average of 19 Jersey cows in the herd. Income above feed cost per cow was $308.27, which was slightly higher than the previous year, despite the high cost of feed.

In addition to income from sale of milk, nine cows, four heifers and one bull calf were sold during the year. All except three of these were

sold to farmers to be used in improving their herds. At this time there are 38 head of dairy stock on the farm, including 21 cows, 3 heifers, 12 heifer calves, 1 herd bull, and 1 bull calf.

Poultry flocks.—Twelve hundred baby chicks were brooded this year. Continuing a study of protein supplements in the growth ration, half of the pullets were fed a mixture of equal amounts of meat scrap and distillers' dried solubles and the other half were fed equal amounts of soybean meal and distillers' dried solubles as a protein supplement. Both of these rations proved satisfactory and there was very little difference in the growth of the chicks. Egg production records are now being kept on the pullets produced under these two systems of feeding.

Poultry flocks now include five pens containing a total of 464 laying pullets and 48 male birds. About 40 percent of these are Barred Plymouth Rocks and about 60 percent are New Hampshires.

During this year the practice of keeping two pens of old hens, representing almost one-third of the laying flocks, was discontinued because previous tests proved that it was more profitable to keep only pullets.

Pasture experiment. — The three experimental pastures, which are on poor sandstone land of the Western Kentucky Coal Field Area, were again grazed with yearling Hereford steers. Weights gained by the steers during the season and the average gains per year during the 20 years of grazing are shown in the following table:

	Pounds of Gain per 10-Acre Field	
Total Treatment, 20-Year Period	*1948*	*20-year-average*
None	525	482
3,407 pounds rock phosphate	1875	1632
1,863 pounds 20% superphosphate and 2½ tons limestone	2055	1642

Comparison of phosphate fertilizers on limestone soil.—On soil of limestone origin, 40-mesh fused phosphate carrying 30 percent total P_2O_5, is being compared with 20 percent superphosphate, 45 percent triple-superphosphate, and fine-ground raw rock phosphate with 30 percent total P_2O_5. Rock phosphate is applied at rate of 120 pounds of total P_2O_5 and the other phosphates are applied at rate of 60 pounds of total P_2O_5 per acre for a 3-year rotation of corn, wheat, and hay. Lime, potash, and manure are used with each kind of phosphate. In 1948 plots treated with 40-mesh fused phosphate produced the greatest total yield and highest increase in yield of corn and hay and those treated with triple-superphosphate produced the highest yield and increase of wheat, although all plots produced high yields. Results to date indicate that fused phosphate and superphosphate, when used at rates to supply equal amounts of P_2O_5, are similar in ability to increase crop yields.

Rock phosphate versus superphosphate on sandstone soil.—An experiment, begun in 1930 on soil of sandstone origin, compares

ordinary superphosphate with fine-ground rock phosphate. Present applications are at the rate of 60 pounds of P_2O_5 from superphosphate versus 120 pounds of P_2O_5 from rock phosphate. Potash, nitrogen, and manure are used uniformly on all plots, some of which are limed and others unlimed. A 3-year rotation of corn, wheat, and hay is followed. Average results for 17 years show a slight advantage on this sandstone soil in favor of the rock phosphate. Comparative yields of corn and wheat in 1948 were as follows:

	Corn	*Wheat*
	bu	*bu*
On unlimed soil		
Superphosphate	65.1	32.1
Fine rock phosphate	72.6	29.1
On limed soil		
Superphosphate	62.3	30.3
Fine rock phosphate	70.3	24.9

Rock phosphate versus triple-superphosphate on limestone soil.—In this experiment, rock phosphate and triple-superphosphate are compared at various rates of applications. All plots receive uniform treatments of limestone, potash, and nitrogen. The limestone was applied at rate of 1 ton per acre in the beginning of the test, in 1940, and is repeated each round of a 3-year rotation at rate of one-third ton per acre. Rock phosphate has been applied each three years at rates to supply 100, 150, and 200 pounds of total P_2O_5 per acre and on one plot at rate of 300 pounds in the beginning and 100 pounds each rotation thereafter. The triple-superphosphate has been applied at rates of 50 and 100 pounds of total P_2O_5 per acre. The highest average yields of corn, wheat, and hay have followed the use of triple-superphosphate at rate of 100 pounds of P_2O_5 per acre; half this amount of triple-superphosphate has produced yields more than equal to those produced by rock phosphate used at rates to supply three to four times as much total phosphorus. Corn and hay yields have been satisfactory, but wheat yields have been poor on the rock phosphate plots. In 1948 the triple-superphosphate treatment, furnishing 100 pounds of P_2O_5 per rotation, produced 87.5 bushels of corn, 32.3 bushels of wheat, and 4,425 pounds of hay. Yields from rock phosphate plots, receiving 200 pounds of P_2O_5, were 76.1 bushels of corn, 18.5 bushels of wheat and 2,800 pounds of hay.

Effect of legumes on soil productivity.—In this experiment, begun in 1927, the effect of different legumes in maintaining or increasing crop yields is measured by yields of corn and wheat obtained following various legume plants in a 3-year rotation of corn, wheat, and legume hay. All plots reported herein have received the same treatment of phosphate and potash and all have been similarly limed, except that the cowpea and soybean plots were not limed. In 1948 the two highest yields of corn, 94.6 and 91.4 bushels per acre, followed lespedeza hay and sweet clover hay, respectively; corn following alfalfa yielded 83.1 bushels, and following

red clover hay, 82.3 bushels per acre. Wheat yields were highest, 32 bushels per acre, in the rotation where red clover was the hay crop. The second highest wheat yield, 26.1 bushels per acre, occurred in the rotation with alfalfa as the hay crop. The lowest yields of corn and wheat followed cowpea or soybean hay.

These results are in line with a summary of the past nineteen years which shows the highest average corn yield, 55.9 bushels per acre, was produced following lespedeza or sweet clover and the highest wheat yield, 20.5 bushels, was produced where red clover hay was the third-year crop.

Fertilizing burley tobacco.—Tests of rates of application of nitrogen, phosphorus, and potash fertilizers for burley tobacco, begun in 1947, were continued on the same plots this year. The land used in this test, though previously fertilized moderately, received no fertilizer from the fall of 1943 until the experimental treatments were applied on certain plots in 1947 and again in 1948.

Yields of burley on the untreated check plots in 1948 averaged 1,274 pounds per acre. No increase was obtained from the use of superphosphate at rates of 40, 80, or 120 pounds of P_2O_5 per acre. The highest yield of the test, 2,170 pounds per acre, was obtained from a plot which received no phosphate but was treated with 120 pounds of nitrogen and 120 pounds K_2O (potash) per acre. No increase was obtained from the use of 40 pounds K_20 per acre but slight increases in yield resulted from the use of 80 and 120 pound applications. Each rate of application of ammonium nitrate, in addition to phosphate and potash, resulted in a marked increase in yield. When used at rates of 40, 80, and 120 pounds of nitrogen per acre, the yields increased 340, 570 and 740 pounds per acre, respectively, as compared with yield of a plot treated only with phosphate and potash.

Fertilizer placement test with burley tobacco.—A fertilizer placement test with burley tobacco was started this year, primarily a study of methods of applying fertilizers. The test is on land adjacent and similar to that described under the fertilizer rates test, except that it remained in red clover, sweet clover, lespedeza, and grass in 1947. Second-year red clover and sweet clover were plowed under ahead of the 1948 tobacco crop. The season was favorable, with an abundance of rainfall during the summer, and good yields were obtained. The unfertilized check plots averaged 2,025 pounds per acre. Fertilizer treatments produced unusually small increases in yields. Five methods of applying fertilizers were compared. The total fertilizer treatment was 80 pounds per acre each of N, P_2O_5 and K_2O, regardless of the method of application. Methods used and yields obtained were as follows:

All fertilizer broadcast and disked in, after land was plowed	2,290 pounds per acre
All fertilizer applied at row at time of setting	2,170
60 pounds of each ingredient in plow furrow and 20 pounds of each at row at time of setting	2,160
All broadcast before plowing	2,150
60 pounds of each ingredient broadcast before plowing and 20 pounds of each at row at time of setting	2,120

Dark tobacco varieties.—Eight dark tobacco varieties, the best of previous selections here, were grown in comparison with eight mosaic-resistant strains and one new strain resistant to both mosaic and black root rot. Yields were as follows:

Variety	*Yield per Acre*
	lb
Strains of Mosaic Resistant Brown Leaf	
Ky 153	2028
Ky 151	1819
R27-44	1697
Brown Leaf	1951
Little Crittenden	1874
Mosaic Resistant Little Crittenden	1831
Little Orinoco	1800
Mosaic Resistant Little Orinoco	1759
Strains of Mosaic Resistant One Sucker	
Ky 160	1824
R20-30-31-50-28-'44	1728
Ky 161-1	1714
R15-'47, resistant to both mosaic and black root rot	1444
W Ky 2	1855
W Ky 1	1786
Ky 141	1779
Madole	1678
Clarksville Broadleaf	1650

Fertilizing dark air-cured tobacco.—In this test tobacco is grown in a 3-year rotation of tobacco, cover crop clipped, and legume and grass hay. The 1948 crop followed one complete round of the rotation and two fertilizer applications at 3-year intervals.

A plot which had received no treatment during the past 8 years and which previously received only superphosphate, produced 1,098 pounds of tobacco per acre. Seven plots, untreated before 1945, now limed and treated with 60 pounds of P_2O_5 and 10 tons of manure per acre, produced an average yield of 1,542 pounds per acre. Only three treatments resulted in a higher yield than this basic treatment of lime, phosphate, and manure. The highest yield, 1,758 pounds per acre, resulted from the use of a mixture of 100 pounds of nitrogen, 120 pounds of phosphoric acid (P_2O_5) and 120 pounds of potash (K_2O). Where this complete mixed fertilizer was reduced to 60-60-60, the second highest yield of 1,648 pounds was produced. Where nitrogen or potash was omitted or where nitrogen was reduced to 30 pounds per acre, the yields were less than that from the lime, phosphate, and manure treatments. The two most practical and profitable treatments used were the 60 pounds P_2O_5

and 10 tons of manure, and the 60-60-60 mixed fertilizer, each used on limed land.

Corn varieties.—In the *corn variety test* 14 white hybrids were compared with Boone County White and 9 yellow hybrids with Reid's Yellow Dent. Each kind of corn was replicated five times on a total of 125 plots of 30 hills each, planted 42 inches apart each way. The highest average yield of white corn, 98 bushels per acre, was produced by Ky 416, but on one single replication Ky 412 yielded 118 bushels. The yield of Boone County White averaged 82 bushels, ranging from 70 to 104 bushels per acre. The highest average yield of yellow corn, 89 bushels per acre, was produced by Dixie 44, with one plot of this kind yielding 99 bushels per acre. The average acre yield of Reid's Yellow Dent was 79 bushels. The season was unusually favorable for corn production.

Wheat varieties.—Nine varieties of wheat were tested this year. Arranged in order from highest to lowest yield, average of two replications, these were: Redheart, Currell's Prolific—R47, Thorne, Vigo, Clarkan, N. S. 6, Forward, Trumbull, and Fairfield. Yields ranged from 18 to 24 bushels per acre. Redheart produced 3 bushels more than adjacent plots of Currell's Prolific—R47. The other varieties yielded 1 to 4 bushels less than Currell's Prolific—R47, which was used on alternate plots as a check variety. Leaf rust was unusually severe this year. Early maturing varieties suffered less from this disease than later kinds. This may account for the higher yield of Redheart, in contrast to 1947 yield when it ranked sixth.

Apple varieties.—Lodi, again the outstanding new apple under test, produced heavier than Yellow Transparent and Red Bird trees of the same age and also reached a marketable size of 2¼ inches earlier than Yellow Transparent. Lodi is showing commercial possibilities.

Peach varieties.—The following new varieties fruited for the first time at Princeton and showed promise: Dixired, a very early, yellow clingstone, ripening just ahead of the old Red Bird peach; K-70, a high quality, yellow freestone from the Illinois breeding work; also, Fairhaven, Michigan 125 and Southland. However, Southland blooms early and could be frost tender. Other new varieties under test for some time that continued to show promise were: Erly Red Fre, Redhaven, Fair Beauty, Triogem, South Haven 20, Raritan Rose, Golden Jubilee, Cumberland, Sunhigh, July Elberta, Halehaven, Ideal, Goldeneast, July Heath, Ambergem, Veteran, Sullivan Early Elberta, Summercrest, Golden Gem, Afterglow and Barbara.

Some peach varieties suffered seriously from *Bacterium pruni*, both on fruit and foliage, as follows: Elberta, Sullivan Early Elberta, Tena, Sunhigh, K-63, K-61, K-43 (Prairie Rambler), K-47 (Prairie Clipper),

K-55, Golden Gem, and Afterglow. On Tena, K-61, and Cardinal Heath the fruit cracked badly, becoming infected with brown rot, and was virtually all lost.

Plum varieties. — Bruce and Munson were again outstanding as early plums. America, ordinarily a heavy bearer, had its first light crop in years. Gold had a medium crop but again suffered from brown rot. Of the two prune varieties, Early Italian was again heavier fruiting and of better quality than the regular Italian prune. Among the damsons, French Damson was again far superior in yield, quality and fruit size to either Shropshire Damson or Blue Damson. Also, to date French Damson has not been affected with the plum black knot disease. This trouble has been moderate on Blue Damson and rather serious on Shropshire. French Damson is considered by far the most desirable damson under test at this time and is admirably suited to western Kentucky.

Strawberry varieties.—First crops were harvested from Temple, Fairpeak, and Midland. Temple, a new variety resistant to red stele, produced satisfactorily but the fruit is better adapted to local sales than to shipping. Midland had made virtually no runners in 1947; hence, its yield was very low. The quality and size of Fairpeak was acceptable but the yield was low.

In tests from 1942 through 1948 of major strawberry varieties, the following 7-year average yields in 24-quart crates per acre were secured: Tennessee Beauty, 196; Blakemore, 186; Tennessee Shipper, 166; and Aroma, 91 crates per acre.

The following varieties and selections were planted: Tennessee 965, Tennessee 866, Tennessee 863, Illinois 41-31, Fairland, Midland, Robinson, Sparkle, Temple, Tennessee Shipper, Tennessee Beauty, and Blakemore. Of these, Tennessee 965, Tennessee 866 and Blakemore were most vigorous, followed by Tennessee 863, Robinson, Temple, and Tennessee Shipper. Showing less vigor in this new planting were Fairland, Tennessee Beauty, and Illinois 41-31. Midland showed least vigor of all.

Grape varieties. — Fredonia, a new early black grape again performed outstandingly, producing a heavy crop of high quality, large, black grapes. It was followed by Daisy, Herbert, Wayne, and Muench, other new varieties. Of the new white grapes, Portland was again impressive, but not so impressive as Fredonia for the blacks. Portland was followed by Seneca and Ontario. Seneca is the best quality white eastern grape and is the earliest of all to ripen. However, vine growth and yields have been only moderate, to date. Its high quality and long keeping quality give it a place in any home grape planting. Golden Muscat, though producing well, again showed a weakness for black rot, a disease to which the variety is subject in many other locations and trials.

Of the older varieties, Concord did well for the blacks; Delaware,

Dunkirk, Ellen Scott, and Catawba, for the reds; and Niagara and Winchel, for the whites.

After-effects of 2,4-D sprays on Winesap and Stayman apples.—In early October 1947 several Winesap and Stayman trees received a stop-drop spray of 2,4-D at the rate of 7 to 8 ppm. This material was effective in reducing the dropping of fruits from the sprayed trees. Some workers in other states had reported distorted foliage the following season on trees that received such sprays. No abnormalities in the foliage or fruit of these Winesap and Stayman trees were found in 1948.

Apple scab control.—Stanofide, a new concentrated fungicidal material, gave very poor control of apple scab on foliage and fruit in a small spray test where it was applied in pre-pink, pink, calyx, first and second cover sprays on Delicious, Winesap, Kinnard, and Winter Banana. In a nearby planting, excellent scab control was had with lime sulfur (2 gallons per 100) applied in the pre-pink and pink stage followed by wettable sulfur and fermate in the calyx, first and second cover sprays. Sprays in both plots were applied with the same timing and the same crew and machinery.

ROBINSON SUBSTATION

General farming.—Growing conditions were favorable and all crops were good, especially corn. From 15 acres planted to Ky 103, there was gathered 1,250 bushels of sound corn, an average of 83 bushels per acre. Some of the acreage produced better than 100 bushels per acre. Eight acres of korean lespedeza, 5 acres of alfalfa, and 8 acres of oats were harvested for hay, and all was saved in good condition. Pasture acreage was increased and there are now 20 acres of bottomland pasture and 30 acres on the hills.

Livestock and poultry.—The project on breeding up dairy cattle by the use of purebred Brown Swiss bulls on scrub and grade Jersey cows is in its sixth year, and there has been marked improvement in the individuals since the project was begun. The herd now consists of one purebred Swiss bull, two purebred Swiss cows, two Jersey cows, and 11 grade Swiss-scrub cows. In addition to the cows, there is one purebred Swiss bull calf, two purebred Swiss heifers, two grade bull calves, and thirteen grade heifers and heifer calves. In all there are thirty-four animals in the herd.

One thousand baby chicks and 300 poults were brooded this year. The turkey eggs for the hatch were produced here and the hen eggs were produced here or at the Western Kentucky Substation. After disposing of the surplus as fryers and in other ways, 300 chicken pullets and 40 turkey pullets were retained as layers.

Sorghum experiments.—In the fertilizer experiment, on a poor sandy soil, sorghum on the untreated plots produced 20 ten-pound pails of sirup

per acre. The highest yield, 99 pails per acre, was produced on the plot limed earlier in the experiment and fertilized, before planting, with the equivalent of 4-8-4 fertilizer at the rate of 400 pounds per acre per year. The similarly fertilized but unlimed plot produced 95 pails per acre. Practically all the increase in yield of sirup was produced by the nitrogen component of the fertilizer.

In the variety test the purpose was to discover a variety superior to Williams in strength of stalk and equal to or not seriously inferior in other characteristics. None of the varieties tested was superior in strength of stalk, and all were less resistant to disease.

Fruits.—Practically all peach fruit buds were killed by temperatures that reached −16° F at mid-February in 1948, destroying the crop. Apples were seriously injured by heavy frosts at blooming time which reduced the crop. The effects of quince rust and cedar rust were also much in evidence.

A partial crop was produced by the older, improved varieties of black walnuts, Thomas and Stabler—also by Major, Green River, and Busseron pecans.

Additional grape vines were sent to Quicksand for replants and enlargement of the new planting started in 1947. The new cooperative TVA walnut planting was enlarged.

NEW PROJECTS—1948

A study of the physical and chemical properties of burley tobacco.

Control of weeds in agronomic crops with 2,4-D and other chemicals.

Factors affecting the chemical composition and physico-chemical properties of milk.

Simplified rations for growing pullets.

Dried corn distillers' solubles, dried corn distillers' solubles fortified with vitamins and minerals, and condensed fish solubles with soybean oilmeal as protein supplements for growing fattening pigs in dry lot.

Influence of level of nutrition on semen characteristics and breeding ability of boars.

Utilizing distillers' dried solubles in the ration of dairy calves.

Dried corn distillers' solubles versus soybean oilmeal as protein supplements for yearling steers wintered in dry lot.

The value of distillers' dark grains as a protein supplement for steers fattened in dry lot.

A comparison between various feeding and management practices for maintaining high milk production during summer months.

A comparison of various grass silages as roughages for pregnant ewes.

Improving conception in Kentucky purebred and in commercial ewes.

Carcass characteristics of Kentucky spring lambs as compared with those of Western fed lambs.

Diseases of equine fetuses and foals.

Parasitic diseases of sheep.

The pharmacology and therapeutics of antibiotic agents in domestic animals.

Control of the plum curculio, oriental moth and cat-facing bugs on peaches.

Biology and control of the northern corn rootworm, *Diabrotica longicornis* (Say).

Biology and control of grasshoppers.

Control of insect pests affecting cucurbits.

Control of plant lice on winter greens.

Biology and control of horseflies affecting livestock.

Influence of radioactive materials on plant growth. Determination of the effect of additions of radioactive materials to soil and fertilizer on the growth, maturity, yield and composition of tomatoes.

The interrelationship of hormones and nutrients and their effect on the production and quality of tomatoes.

The development of new fruits adapted to Kentucky.

A study of the economics of pastures with particular reference to areas in Kentucky in which tree growing is the chief competing enterprise to the growing of grass.

A study of families on small farms.

A study of rural social organization in Kentucky.

Trends in rural population.

Cooperative marketing of tobacco in Kentucky.

Economic analysis of dark tobacco pools in Kentucky and Tennessee.

PUBLICATIONS

BULLETINS

512. Periodic ophthalmia of horses and mules. W. W. Dimock, D. W. Bruner, and P. R. Edwards. January 1948.
513. Injury to tobacco seedlings from excessive fertilizer applications. C. E. Bortner, M. E. Weeks, and P. E. Karraker. January 1948.
514. Life history of *Conoderus lividus* (Deg.). H. H. Jewett. March 1948.
515. Tobacco stalks, hemp hurds, and sorghum bagasse as sources of cellulose for making high-quality paper. E. B. Lewis, Dana G. Card, and J. S. McHargue. March 1948.
516. Effect of improved land husbandry on income and organization of rolling-land farms. George B. Byers and Wm. G. Survant. April 1948.
517. External parasites of chickens and their control. P. O. Ritcher and W. M. Insko, Jr. May 1948.
518. Management of forests in an Eastern Kentucky area. William A. Duerr and R. O. Gustafson. May 1948.
519. Land ownership and use in Kentucky. John E. Mason and John H. Bondurant. June 1948.
520. Price differences for slaughter hogs, 1937-41, at markets where Kentucky hogs are sold. C. D. Phillips. June 1948.
521. Systems of farming for the Lower-Ohio-Valley crop-livestock region of Kentucky. George B. Byers. June 1948.
522. Farm wage workers in Central Kentucky. John H. Bondurant and Charles E. Bishop. July 1948.
523. Neighborhood standing and population changes in Johnson and Robertson counties, Kentucky. Merton D. Oyler. August 1948.
524. Religious organization in Kentucky. Harold F. Kaufman. August 1948.
525. The genus *Salmonella*. Occurrence and distribution in the United States. P. R. Edwards, D. W. Bruner, and Alice B. Moran. October 1948.
526. Cooperation among Kentucky farmers. H. B. Price, C. M. Clark, and L. A. Vennes. December 1948.
527. Packing and shipping green-wrapped tomatoes in different types of containers. C. D. Phillips and Homer C. Evans. December 1948.

The following bulletins were reprinted:

437. Tobacco diseases. W. D. Valleau, E. M. Johnson, and Stephen Diachun.
463. Farm management handbook based on studies of Pennyroyal farms. Ernest J. Nesius, Charles R. Sayre, David L. MacFarlane, and Robert E. Graham.
484. Costs in owning and operating farm implements and machinery in Kentucky. George B. Byers.
486. Value and use of tobacco stalks in farm practice. M. E. Weeks and P. E. Karraker.
499. Arizona group of paracolon bacteria. P. R. Edwards, Mary G. West, and D. W. Bruner.
507. Farms and forests of eastern Kentucky in relation to population and income. An appraisal of population and land resources and their potentials. William A. Duerr, John H. Bondurant, W. D. Nicholls, Howard W. Beers, R. O. Gustafson, and John B. Roberts.
510. The Louisville fall-premium plan for seasonal milk pricing. John B. Roberts.
516. Effect of improved land husbandry on income and organization of rolling-land farms. George B. Byers and Wm. G. Survant.

REGULATORY BULLETINS

61. Quarterly report on official feed samples analyzed. April, May, and June, 1947. Bruce Poundstone. June 1948.
62. Quarterly report on official feed samples analyzed. July, August, and September, 1947. Bruce Poundstone. July 1948.
63. Quarterly report on official feed samples analyzed. October, November, and December, 1947. Bruce Poundstone. August 1948.

64. Quarterly report on official feed samples analyzed. January, February, and March, 1948. Bruce Poundstone. September 1948.
65. Commercial fertilizers in Kentucky, 1947. July-December, 1947. Bruce Poundstone. October 1948.
66. Quarterly report on official feed samples analyzed. April, May, and June. Bruce Poundstone. October 1948.
67. Some items of interest to Kentucky nurserymen, for year ended June 30, 1948. W. A. Price and Howard Tilson.
68. Seed inspection in Kentucky, 1947-48, by the Entomology and Botany Department, Kentucky Agricultural Experiment Station. Annual Report for the year July 1, 1947 to June 30, 1948. W. A. Price. December 1948.

ANNUAL REPORT

Sixtieth annual report of the Experiment Station (for 1947). Thomas P. Cooper, Director. June 1948.

EXPERIMENT STATION CIRCULAR

52. Grass farming for improving depleted soils. (Reprinted)

MISCELLANEOUS

Kentucky Fruit Notes. (Issued quarterly, January, May, August, and November.) W. D. Armstrong.
The Kentucky Feeding Stuffs Law. Reprinted.

SCIENTIFIC PAPERS

In Agronomy

Combining resistance to wildfire, mosaic, black root-rot, and fusarium wilt in burley tobacco. W. D. Valleau. Abstract in Phytopathology 38: 27, January 1948.
The determination of total boron in plant material with "Chromotrope-B." Calvin M. Austin and J. S. McHargue. Assoc. Off. Agr. Chem. Jour. 31: 427. 1948.
The fractionation and properties of clays from the surface soils of the Pearman and Maury series. W. A. Seay and M. E. Weeks. Soil Sci. Soc. Amer. Proc. 12: 24-28, 1947. (Appeared in 1948.)
The influence of nitrogen, potassium, and magnesium salts on the composition of burley tobacco. H. J. Evans and M. E. Weeks. Soil Sci. Soc. Amer. Proc. 12: 315-322. 1947. (Appeared in 1948.)
Inhibition of tobacco streak virus by juice from healthy plants. Stephen Diachun. Abstract in Phytopathology 38: 7. January 1948.
Interpretation of yield data from a long-time soil fertility experiment. G. L. Terman and J. F. Freeman. Amer. Soc. Agron. Jour. 40 (10): October 1948.
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FINANCIAL STATEMENT

Receipts and expenditures under Hatch, Adams, Purnell, Bankhead-Acts and under Sections 9(b)1 and 9(b)2 of the Research and Marketing Act and the State Offset Required by the Bankhead-Jones and Research and Marketing Acts

Fiscal Year Ended June 30, 1948

Receipts	Hatch	Adams	Purnell	Bankhead-Jones	Research and Marketing 9(b)1-9(b)2
From the Treasurer of the United States as per appropriations for fiscal year ended June 30, 1948	$15,000.00	$15,000.00	$60,000.00	$88,327.81	$57,702.48
Expenditures					
Personal Services: Administration	13,491.08				
For all other purposes		15,000.00	52,496.91	81,310.98	31,521.50
Travel	147.42		2,607.52	267.88	3,604.92
Transportation of things			21.59	13.80	11.72
Communication service			10.15	46.85	9.20
Printing and Binding: Printing publications	1,286.50		4,073.78	1,869.50	
Other Contractual Services: Repairs and alterations to equipment, and other contractual services not otherwise classified			120.93	161.29	6.32
Other supplies and materials	75.00		604.52	3,754.09	2,296.16
Equipment			64.60	903.42	1,117.77
TOTAL EXPENDITURES	15,000.00	15,000.00	60,000.00	88,327.81	38,567.59
Unexpended balances, June 30, 1948	.00	.00	.00	.00	19,134.89
BANKHEAD-JONES AND RESEARCH AND MARKETING, 9(b)1 AND 9(b)2, OFFSETS, TOTAL APPROVED EXPENDITURES					$146,030.29

We the undersigned, certify that the receipts and expenditures shown in this report from Federal funds and as offset to Bankhead-Jones and Sections 9(b)1 and 9(b)2, of Title I, Research and Marketing funds are correct; that the expenditures were solely for the purposes set forth in the acts of Congress approved March 2, 1887 (Hatch), March 16, 1906 (Adams), February 24, 1925 (Purnell), May 16, 1928 (Hawaii), March 4, 1931 (Puerto Rico), June 29, 1935 (Bankhead-Jones, Title I), March 4, 1940 (Employer Contributions to Retirement), and August 14, 1946 (Research and Marketing, Sections 9(b)1 and 9(b)2, Title I); that the expenditures are in accordance with the terms of said acts so far as applicable to this station; and that properly approved vouchers are on file for all expenditures.

Signed:

THOMAS COOPER
Director of Experiment Station

FRANK D. PETERSON
Comptroller
(Legal Custodian of Federal funds)

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